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ADNOC

ADNOC PHYSICAL HEALTH HAZARDS MANAGEMENT CORPORATE PRACTICE

HSE-OH-CP02

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01. INTRODUCTION

The ADNOC Occupational Health Management Manual (GHSE/MAN-02) provides the mandatory requirements for effective management of occupational health risks at the workplace. It is the ADNOC Group HSE policy to ensure that its employees and contractors are protected from occupational health risks that they could be exposed to. This Physical Hazards Corporate Practice (CP) provides the guidance required to meet the requirements of the Manual .

It furthermore provides the methods to be considered on hazard identification, risk assessment and risk control practices of physical hazards present in ADNOC workplaces. It is also required that risk management process is based on solid and tested methodologies.

ADNOC Group including Group Companies (GCs) is committed to having a world-class emergency response provision, in line with its Corporate HSE Policy.

The requirements outlined in this Corporate Practice will assist Group Companies and SPC Affiliates in achieving corporate objectives, provided that strict, disciplined, and sustained compliance is maintained. Additionally, adopting and customizing the prescribed generic framework for Occupational Health throughout the organization is essential.

02. SCOPE

This document provides the guidance required, to be considered, in order to achieve the requirements of the approved Occupational Health Manual.

(i) This Corporate Practice provides a framework and detailed guidance on:

(ii) Various physical agents present in the work environment;

(iii) Health effects of physical hazards when a worker is exposed;

(iv) Evaluation of health risks associated with physical agents present in the working environment;

(v) Controlling the risks to As Low as Reasonably Practicable (ALARP); and

(vi) Meeting Legislative and Regulatory requirements (e.g., FANR).

This document stipulates the mandatory requirements applicable to ADNOC Group (Directorates & Functions in ADNOC Head Quarter, Group Companies and Affiliates) and its Contractors.

This Corporate Practice outlines the requirements for management of the following Physical Hazards:

(i) Noise;

(ii) Vibration;

(iii) Heat Stress;

(iv) Radiation (Ionizing and Non-Ionizing);

(v) Naturally Occurring Radioactive Material (NORM);

(vi) Hyperbaric Pressure.

Therefore, ADNOC Groups and Contractors shall ensure that all expectations provided herein are fully understood and implemented.

03. ROLES AND RESPONSIBILITIES

JOB POSITION	ROLES & RESPONSIBILITIES
ADNOC Senior Management (i.e. Unit/ Function /HSE/Facility Manager)	▪ Ensures adequate resources are made available such as training covering all topics in this Corporate Practice. ▪ Defines the roles and responsibilities of line managers, specialist advisors [where applicable], supervisors and the workforce in the implementation this Corporate Practice; ▪ Ensures implementation this Corporate Practice and allocation of resources.
OH SME (i.e. OH Specialist)	▪ Ensures all physical hazards at the facilities are addressed during the preparation of Occupational Health Risk Assessment. ▪ Responsible in the determination of risk ratings of Physical Hazards, taking into account of existing and additional controls ▪ Ensures that corrective and preventive actions implemented in timely manner. ▪ Advises the assessment team on the screening and performance criteria that will be applied to judge the outcomes of Physical Hazards assessment and controls
Site Clinic/LHCP	▪ Perform the required medical or laboratory test to identify employees who are at high risk of heat stress
GHSE	▪ Defines the appropriate Corporate Practice with respect to assessment of Physical Hazards, including its methodology
Contractor HSE	▪ Ensures following the requirements of conducting Physical Hazards in line with this Corporate Practice by minimizing exposure of their employees to ALARP
Employees	▪ Take appropriate measures to protect the health & safety of him/herself and co-workers and comply with applicable requirement of this Corporate Practice; Attend training and awareness sessions on physical hazards, when offered; and ▪ Report incident related to Physical Hazards incidents.
Key Personnel for Radiation Protection	
Qualified Expert in Radiation Protection (QE)	▪ The QE shall be a senior level RPO with administrative decision-making authority to communicate with FANR for ADNOC Group.

JOB POSITION	ROLES & RESPONSIBILITIES
	▪ Provides advice on and/or conduct activities in their field of specialization, which include but not limited to: design of radiation exposure controls; specific recommendations for radioactive source rupture or breakage; and **development of radiological emergency plans.**
Radiation Protection Officer (RPO), Sites	The Site-Based RPO shall: ▪ Provides information, instruction, and supervision regarding radiation sources; ▪ Ensures that employees are instructed on the appropriate use of personal radiation dose badges and other equipment; ▪ Assists in the development, implementation, and enforcement of site specific procedures for the performance of radiological work as FANR Regulations; ▪ Ensure the conduct of **leak and survey testing** for radioactive sources and equipment as per FANR Regulations; ▪ Ensures that baseline/pre-work surveys for NORM are conducted to determine the presence of NORM at the facility. ▪ Ensures regular inspections are conducted to monitor contamination and ensure that the appropriate decontamination procedures are followed if necessary; ▪ Ensures that no person undertakes radiological work unless they are correctly trained and certified. ▪ Be responsible and accountable for the safe transport and custody of sealed radioactive sources ▪ Monitors records of radioactive discharge into the environment to ensure that this is limited to ALARA and always below levels permitted by regulation, as well as Radioactive Sources and X-ray radiation generators; ▪ Advises and coach employees involved in implementing this Corporate Practice on Radiation, particularly with regards to implementing controls; ▪ Prepares legal and **radioactive registers** and track all applicable Radiation protection compliance requirements, including maintenance/updating of such registers for the GC; and its periodic submission to GHSE Evaluates/ensures full compliance to FANR Licenses and other applicable requirements in terms of Documentation, Monitoring and Reporting. ▪ Provides Radiation Safety oversight of industrial radiography activities; ▪ Inspects radiation safety and warning features of radioactive equipment, as well as resolving problems; ▪ Oversees radiation controlled and supervised areas; Supervises personal dosimetry and workplace monitoring arrangements, including reviewing, maintaining, and updating occupational dose records, as well as supervising workplace monitoring arrangements; ▪ Ensures radiographers receive radiation safety training; ▪ Ensures **Radiation Emergency Plans are established and practised regularly; may carry out or directly supervise contingency plans** in the event of an Accident or Incident

JOB POSITION	ROLES & RESPONSIBILITIES
	▪ Establishes, issues and reviews local rules, that is, the procedures for carrying out radiography work (including work permits where appropriate); and ▪ Investigates incidents, including higher than usual exposures and overexposures, and accidents, and reporting them as appropriate.
NDT Competent Person	The NDT shall: ▪ Ensures that the legal and HSE aspects of radioactive substances and ionizing radiation at work are in compliance as advised by the RPO and/or given in the local procedure. ▪ Liaises with Radiation Protection Officer to get advice on legal and HSE aspects of radiation work, when needed. ▪ Ensures all Regulated Radioactive Materials and equipment that generate radiation available at site are registered in the database for review and update. ▪ Ensures that the radiation exposure dose is being measured for radiological workers and recorded information are sent to the lab for analysis and report. ▪ Coordinates with RPO to ensure that ADNOC Group Import Permits and License (new and amendments) are obtained for all radioactive sources available at site. ▪ Liaises with RPO to ensure safe handling and disposal of radioactive waste by end user.

04. REQUIREMENTS

4.1. OVERVIEW

Physical agents potentially associated with the range of activities conducted by ADNOC Group and their Contractors include Noise, Vibration, Heat Stress, Radiation (ionizing and non-ionizing), NORM and Hyperbaric Pressure. Furthermore, there are activities where certain groups may be working in environments where ambient pressure is higher than atmospheric (also known as a hyperbaric environment) and this carries its own occupational health risks.

The range of physical agents present in the workplace, their likely sources and the potential health effects associated with each are tabulated below, in Table 4.1.1.

Table 4.1.1: Workplace Physical Agents and its Health Effects

Likely Occupational Source(s)	Potential Health Effects
Noise	
Plant and machinery, compressors, construction and civil works, maintenance activities, use of powered tools, hammering, drilling, and release of high pressure.	Temporary loss of hearing if exposed to loud noise for short periods. Noise-induced hearing loss (NIHL) leading to total deafness after prolonged, regular noise exposure. Tinnitus (ringing in the ears).
Vibration (Hand Arm & Whole Body)	
Vibration transmitted to hands through use of power tools, pneumatic breakers, concrete and stone cutters, masonry drills, angle grinders, rotary sanders, needle chisel scalers, etc.	Tingling and numbness in hands and fingers. Hand Arm Vibration Syndrome & Carpal Tunnel Syndrome, Raynaud's syndrome (white finger).
Vibration transmitted to back and other skeletal structures of body through the seat or feet of drivers of tractors, cranes, forklift trucks and quarrying or earth-moving machinery.	Vibration and/or musculoskeletal disorders.
Thermal Environmental (Heat)	
Working in direct sunshine, or hot and humid shaded areas. Also adjacent to hot and reflective surfaces that radiate heat (e.g. kitchens, boilers, gas burners, heat exchangers, etc.).	Symptoms of ill-health such as heat rash; cramps; syncope; heat exhaustion; and heat stroke.
Non-Ionizing Radiation (Electromagnetic Radiation)	
Infrared sources include furnaces, heat lamps, and IR lasers.	Heat sensation & pain in the eye. Glassblower's cataract.
Ultraviolet sources include arc, TIG & MIG welding, sun, black lights, and UV lasers.	Sunburn, conjunctivitis, arc eye, and skin cancers, damage to immune system, eye damage, skin ageing and also include photokeratitis and erythema.
Extremely Low Frequency (ELF) radiation at 60	Symptoms include Excessive heating of any

Likely Occupational Source(s)	Potential Health Effects
Hz produced from power lines, electrical wiring, and electrical equipment. Common sources of intense exposure include ELF induction furnaces and high voltage power lines.	exposed part of the body, carcinogenic, reproductive, and neurological effects, cardiovascular, brain and behaviour, hormonal and immune system changes. Clinical evidence needs to be established.
High Frequency [HF] sources such as radiofrequency and microwave radiation include radio emitters, cell [mobile] phones, two-way radios, and plastic welding equipment.	Symptoms include high enough intensity; it will damage tissue through heating may result into dementia. Clinical evidence needs to be established.
Ionizing Radiation (X-rays, and α, β, γ-rays)	
Radiography & imaging equipment, NORM, radioactive sources used in Non-Destructive Testing	Impotency, depilation, burns, dermatitis, cancer, cell damage or blood changes, cataracts. Acute radiation sickness.
Hyperbaric (i.e. Above Atmospheric Pressure)	
Diving and working at deep sea locations	Extensive and diverse symptoms depending on conditions and circumstances resulting into decompression sickness.

4.2. NOISE

4.2.1. COMPETENCE

An entity is required to assign suitably qualified and competent personnel to manage noise monitoring and hearing conservation programs. The competent person shall have the relevant certification to perform noise assessment and control.

4.2.2. RECOGNITION OF NOISE HAZARD

a) Non-Industrial Noise

"Sound" is a natural phenomenon which reflects the movement or pressure changes that occur in the surrounding environment. Humans experience man-made sounds that are produced by traffic [e.g. that emitted by air, sea, and road transportation], construction activities; machinery; air conditioning plants; fans; or from leisure activities [e.g. music, radio, TV, or public address systems]. However, the sound that is universally experienced by everyone from an early age is speech, which is used for daily communication. A healthy human ear can distinguish sounds in the frequency bandwidth of 20 Hz–20 kHz.

"Noise" on the other hand, is the combination of unwanted, interfering and often irritating sounds, regardless of their source.

b) Workplace Noise

Employees' exposure to excessive noise is a recognized potential health hazard. Such exposure may occur during outdoor activities such as working with machinery and equipment, including air compressors, pumps, turbine, boilers, diesel / petrol engines, diesel generator, air coolers, fin fan coolers, heat exchangers, vent and flares, or from indoor activities such as grit / sand blasting or maintenance workshops.

Before measuring the sound levels in workplace, the following shall be considered:

(i) Observation of specific working practices (e.g. Workers not wearing assigned HPE);
(ii) Relevant information pertaining to equipment noise as per manufacturers' specifications;
(iii) Worker exposed to ototoxic substances or vibration;
(iv) Identification on high risk SEGs prone to excessive noise;
(v) The noise risk assessment shall consider the following factors;
(vi) Frequency and duration of exposure including any exposure to peak sound level;
(vii) Availability of alternative equipment designed to reduce the emission of noise (e.g. mufflers, acoustic barriers, dampers, etc.);
(viii) Appropriate information obtained from health surveillance (i.e. audiograms);
(ix) Availability of personal hearing protectors with adequate attenuation characteristics.

4.2.3. HUMAN EAR & HEALTH EFFECTS OF NOISE

The ear is a complex organ which is sensitive to very soft sounds [e.g. whispers] but can also receive loud sounds [e.g. bangs, cracks, and shouting]. However, as the sound pressure becomes louder, the ear experiences pain and in high/medium cases the eardrum may burst.

Prolonged exposure to loud noise, whether it happens socially or through work-related (i.e. occupational) activities can lead to Noise-Induced Hearing Loss (NIHL). This condition is the result of sound pressure impacting on the microscopic hair cells known as Cilia (receptor) located in the middle and inner regions of the ear, causing permanent damage and death to these cells leading to disability to transmit sound signal to the brain.

NIHL starts with loss of hearing at 4000 Hz (audiometric notch) then spreads across the different frequency bandwidths. The loss is manifested by the person not understanding certain letters during speech or listening to TV, radio or other forms of communication. For long-term exposures to high levels of Noise, the full range of audible frequencies is lost, thus leading to total deafness. The exposed person may also develop tinnitus (i.e. ringing, whistling, buzzing or humming in the ear) leading to disturbed sleep and general social life.

a) Conductive Hearing Loss:

It may be temporary or permanent when an individual experiences a ringing sound or muted hearing in one or both ears. Though these effects typically only last for a short period of time, it can damage hearing in the long run [Ref. 20].

b) Sensorineural Hearing Loss:

It is a permanent hearing loss that occurs when there is damage to either the tiny hair-like cells (cilia) of the inner ear or the auditory nerve itself, which prevents or weakens the transfer of nerve signals to the brain.

c) Sociocusis:

Hearing loss incurred from non-occupational noise sources e.g. recreational that develops over time after repeated exposure.

d) Presbycusis:

It is the loss of hearing that gradually occurs in most individuals as they grow older. Hearing loss is a common disorder associated with aging. The loss associated with presbycusis is usually greater for high-pitched sounds.

e) Temporary Threshold Shift (TTS):

Threshold shifts that recover to baseline levels in the hours, days or weeks following exposure are termed TTS.

f) Permanent Threshold Shift (PTS):

PTS can be defined as noise-induced threshold shift that persists after a period of recovery subsequent to the exposure.

In the working environment, loss of hearing has a negative impact on personal morale and poses a serious safety risk to personnel because they cannot hear critical alarms or are able to communicate with their colleagues.

4.2.4. THE NOISE / SOUND SCALE

Sound is generated from a broad spectrum of pressure changes that happen near and at the ear. As a result, sound pressure has to be measured on a base 10 logarithmic scale, which is known as the Decibel (dB). The pressure measurement is also suffixed by one of the letters A or C (e.g. dBA or dBC) to indicate that an electronic frequency filter [i.e. an electronic weighting] has been used during the measurement.

The weightings, enable the Sound Level Meter (SLM) to respond to the same frequencies as those recognized by the human ear. The three weightings correspond to the following settings:

(i) A-weighting, is noise that the human ear can recognize.
(ii) C-weighting, is impact [i.e. pulse or peak].
(iii) Z-weighting, is the flat frequency response of 8Hz to 20 kHz (± 1.5dB). It is the actual noise that is made with no weighting at all for the human ear (Z for zero). Often used in octave band analysis and for determining environmental noise such as peak level in mining and blasting due to extreme low frequency of the shock wave.

4.2.5. CHARACTERISTICS OF SOUND

The main features of sound are outlined below:

a) Intensity

Sound intensity is defined as the sound power per unit area. The usual context is the measurement of sound intensity in the air at a listener's location.

b) Frequency

Human hearing is sensitive to sound that occurs in the frequency band of 20 Hz to 20 kHz, but workplace sounds are composed of a broad spectrum of frequencies, some of which occur in the hearing range, while other do not [e.g. ultrasound or very low frequency sound]. For that reason, when conducting risk assessments of noise at work, the audible frequency range is sometimes divided into smaller bandwidths in order for the measurements to be used for profiling noise [especially from plant and machinery] or for evaluating noise control and the efficacy of hearing protection equipment. The most common bandwidths are the Octave [1/1] and Third [⅓] Octave. The frequencies usually included in the Octave are 63, 125, 250, 500, 1000, 2000, 4000 & 8000 Hz. On the other hand, the ⅓ Octave is divided into 36 frequencies between 6.3 Hz and 20 kHz.

c) Time

There are three time-related noise sources commonly encountered in the workplace. These are described below.

(i) Sources with noise levels that fluctuate by more than ±3 dB are generally defined as **variable or intermittent**. These sources are characterized by long periods of silence which is followed by a loud noise. A typical example is the intermittent use of angle grinders or metal saws in welding and fabrication shops, or the use of road and stone breakers during civil works.
(ii) **Continuous or steady state** sources produce uninterrupted sound, varying by less than ± 3 dB. Typical examples are compressors, fans, motors, boilers, generators, and reverse osmosis plants.
(iii) **Impulse or impact** is characterized by a sharp rise and rapid decay in sound levels and is less than 1 second in duration. These are generated when a collision occurs between two solid objects or by a rapid pressure release. Typical examples are hammering on metal surfaces, dropped heavy objects, doors slamming shut, and opening of pressure release valves, etc.

4.2.6. RISK ASSESSMENT: NOISE EVALUATION

ADNOC Group follows a 3 dB Exchange Rate (ER), which is a trade-off relationship between an increase or decrease in sound level and the corresponding change in allowed exposure duration. When the sound level increases by the decibel value of the ER (i.e., 3 dB), the allowable duration is reduced by half.

Group Companies and contractors shall comply with controlling noise at work through elimination or minimization of exposure to all types of noise to below the Action Values & Limits tabulated below in Table 4.2.6.1

Table 4.2.6.1: Noise Exposure and Compliance [Ref. 15]

COMPLIANCE LIMITS	DAILY 8-HR TWA EXPOSURE, DBA	IMPULSE SOUND PRESSURE DBC
Lower Exposure Action Value. This is the value at which the Company will be required to provide information and training and make hearing protection available for use to all personnel at risk of NIHL.	80	135
Upper Exposure Action Value. This is the value above which the Company shall take reasonably practicable measures to reduce noise exposure to ALARP. At this level, the use of hearing protection is mandatory to all personnel at risk of NIHL.	85	137
ADNOC Noise Exposure Limit. This is the value for 8-hour work shifts.	85	140
Notes:		
Personal noise dosimetry data does NOT take into account any attenuation offered by a hearing protection device.		
1) The compliance limits are set for 8-hr shift periods and cannot be altered. Consequently, assessment of compliance for 12-hr shifts has to be conducted by calculating the time weighted average exposure over the 12 hours, using the equations presented in against the 8-hr TWA limits.		
2) The exposure limits and action values relate specifically to occupational (i.e., work-related) noise exposure. Exposure to noise in non-occupational areas (e.g., accommodation, kitchen area, or leisure areas) is also regulated by maximum permissible limits as defined in UK HSE Noise Regulation 2005 [Ref. 19].		

Table 4.2.6.2: Threshold Limit Values for Audible Sound[A]

TIME DURATION	DURATION PER DAY	SOUND PRESSURE LEVEL DBA[B]
Hours	24	80
	16	82
	8	85
	4	88
	2	91
	1	94
Minutes	30	97
	15	100
	7.50c	103
	3.75c	106
	1.88c	109
	0.94c	112
Secondsc	28.12	115
	14.06	118
	7.03	121
	3.52	124
	1.76	127
	0.88	130
	0.44	133
	0.22	136
	0.11	139
	0.08	140

[A] No exposure to continuous, intermittent or impact noise (e.g., audible sound between the frequencies of 20 and 20,000 Hz) is permitted in excess of a peak C-weighted level of 140 decibels (dB).

[B] Noise levels in dB are measured on a sound level meter conforming as a minimum to the requirements of the American National Standards Institute Sound Level Meters Part 1 Specifications, S1.4 (ANSI, 2007) Type 2, and set to use the A-weighted network with slow meter response.

[C] Limited by engineering control of the noise source if feasible. Administrative control is permissible if engineering control is not feasible

4.2.7. WORKPLACE NOISE CONTROL REQUIREMENTS

Evaluation and control of workplace noise hazards is to observe the requirements provided in this CP. The following requirements shall be adopted for the purpose of employee hearing protection:

(i) All areas with continuous noise levels exceeding 85 dBA shall be considered as high noise areas;
(ii) During presence in an area or around equipment where noise levels are 85 dBA or higher, ear protection shall be required at all times;
(iii) All new projects shall be engineered, where reasonably practical, to meet the 85 dBA noise level limit; as per ROTATING EQUIPMENT MINIMUM GENERAL REQUIREMENTS AND SYSTEM INTEGRATION SPECIFICATION (AGES-SP-05-006); and
(iv) Permanent high noise area shall be identified with warning signage at normal points of entry.

The area noise measurement shall be recorded as detailed in Appendix 1.

4.2.8. CONTROL OF NOISE AT WORK

Entities / GCs are required to implement a hearing conservation and noise control program. Controls to be implemented shall be in accordance with the hierarchy of noise control. It should be noted that noise contour maps should be developed at FEED/EPC (Noise modelling study) and verified at the Operation Stage (within one year of Operation Start up).

Sound controls is to include providing appropriate hearing protection that is to ensure sufficient and effective reduction of personal exposure to noise. Additionally, octave band analysis should be conducted as needed to assess the effectiveness of these controls. It is necessary to carry out follow-up assessments / reassessments to evaluate the effectiveness of controls and determine whether additional measures are necessary.

Entities will be responsible for ensuring that noise signage is installed in accordance with applicable requirements.

International best practice such as the UK HSE Noise Regulations 2005 requires organizations to prevent or reduce risks to health of their employees from exposure to noise at work. Therefore, the following is to be considered:

(i) Assess the risks to employees from noise at work;
(ii) Take actions to reduce the noise exposure that produces those risks;
(iii) Provide employees with hearing protection, if the noise exposure cannot be sufficiently reduced by using other methods;
(iv) Ensure the established limits on noise exposure are not exceeded;
(v) Provide employees with information, instruction and training on noise limits and relevant controls;

4.2.9. NOISE CONTOUR MAPS

A contour map is used to illustrate the distribution of noise across a workplace, thus enabling the ADNOC Group to estimate what noise exposure are experienced by workers at particular locations.

Noise Contours maps shall be developed at FEED/EPC (Noise modelling study) and Operation Stage (within one year of Operation Start up). The map can also be used to:

(i) Identify sources of high noise;
(ii) Monitor noise from machines or processes to highlight the need for maintenance or repair, (e.g. wear in bearings or defective valves);
(iii) Identify low-noise corridors so that the movement of people within the building can be planned to reduce unnecessary exposure; and to
(iv) Check the boundaries of hearing protection zones and use of HPE.

A third party can be engaged to develop Noise Contour Maps, using software (e.g. SOUND PLAN), by quantitatively collecting noise samples from the field. The following maps shall be prepared:

(v) Theoretical Noise Level Contour of the facility;
(vi) Background Noise Level Map of the facility;
(vii) Actual noise contour maps of the operating areas (indicating source of high noise).

a) Noise Modelling (Theoretical Noise Level Contour Maps)

The theoretical noise level contour shall be produced during the FEED stage based on the equipment sound power levels, which represent the total energy emission of the noise sources.

Data required for the noise level contour modelling are, but not limited to, the plot plan (equipment location and elevation), equipment list and power capacity (equipment sound pressure level), and building / barrier configurations.

Since suppliers usually provide only the noise data for individual equipment, the combined effect of all equipment noise is unknown and shall be predicted by the model to determine the area noise levels for the facility.

b) Background Noise Level Maps (for Brownfield Projects)

It is required that the Background Noise Level Map shall be developed by the third-party Contractor as a baseline of the area. These Maps shall be developed based on the theoretical surveys from potential noise readings provided by equipment designer / supplier and interpreted by the third-party contractor. Following the start-up of the new operations/facilities within ADNOC Group, a noise survey shall be conducted at rated operation (standardised conditions), and an actual noise contour map shall be developed to verify the extent of conformity to the performance guarantee.

c) Actual Noise Contour Maps (for Operating Areas)

The noise contour map will identify potentially excessive high noise areas within the operational facility. Administrative measures shall be considered and taken to protect workers, by means, such as classifying an area as a noise hazard area and clearly marking the area with warning signs.

There are benefits to constructing noise contour maps at workplaces with several closely placed noise sources each contributing to the overall noise level. However, noise contours is a mandatory requirement to the assessment of risks to health from noise at work [Ref.51].

Constructing noise contours is relatively simple, requiring an integrating SLM, a GPS, adequate mapping software, a scaled site plan and a competent surveyor. Contours are created from sequential measurements and are used to determine hazard radius, which is the distance from the noise source from at the noise level drops to OEL and below the action level. The distances between two noise contours as well as the dimension of the work area are marked. The materials used to construct the room are also considered for noise dampening purposes.

Detailed contour maps are not needed for all quantitative noise surveys. An excellent alternative can be produced by scanning existing site footprints, then using the drawing & labelling icons available in common word processing or spreadsheet software. Workers operating entirely outside the contour are not exposed to noise in excess of the AL (i.e., 50% of the dose). Workers whose tasks take them closer to the equipment might experience exposures between the AL and the PEL, or even in excess of the PEL. Take photographs to document the type of equipment or process.

4.2.10.RISK ASSESSMENT

Each respective entity / GC is required to perform qualitative and / or quantitative noise risk assessments, and when deemed necessary include noise mapping and personal dosimetry to evaluate the risk to personnel. Continuous noise exposure monitoring is to be conducted for Similar Exposure Groups when necessary.

These risk assessment(s) of noise should follow the applicable standards and legislation deemed fit for the purpose of preventing and controlling noise-related risks. This is to include exposure limits for 8 hour and 12-hour shifts, making use of specialized instruments such as sound level meters, dosimeters, and calibrators.

Risk assessment and exposure monitoring should conform to local regulatory requirements and internationally recognised best practices.

All noise monitoring equipment should be calibrated to a traceable international standard within the last two years.

The entity will be required to ensure health surveillance is completed for personnel exposed to significant noise levels.

a) Qualitative Assessment

ADNOC Group and Contractors shall carry out risk assessments where there is the likelihood of an employee being exposed to noise at or above any of the levels cited as per ADNOC OHRM Corporate Practice HSE-OH-CP01 [Ref. 55]. The objective of the risk assessment is to identify what actions shall be taken to ensure that the risks to health are eliminated or minimized. The company should also recognize that the scope of the risk assessment is wider than the simple task of taking measurements, since in some cases these may not be needed.

The objectives of the risk assessment shall be to [Ref. 30]:

1. Identify where there may be a risk from noise exposure and who may be at risk;
2. Provide a reliable estimate of noise exposure and a comparison of this against the set limits (refer to Note below);
3. Identify what actions need to be taken to control exposure, based on the hierarchy of control; and
4. Profile groups of personnel who are at high or high medium risk for inclusion in a health surveillance program (i.e., if personal noise dosimetry levels reach 50% of its dose as per 95th percentile of the worker group profile).

Note: Reliable estimates of noise exposure shall be representative of workplace conditions and shall take into account of (a) work / tasks carried out; (b) working practices; and (c) noise types & frequencies; and (d) exposure patterns of a working day.

The framework for carrying out risk assessments is detailed in ADNOC OHRM Corporate Practice HSE-OH-CP01 [Ref. 55]. In that respect, assessments shall be carried out by competent personnel and the information collected during the assessment shall be reliable and reflective of current plant and operating conditions.

The assessment is to be recorded and shall contain a plan showing prioritised actions for dealing with the high and medium risks, as well as a timed schedule of actions/deliverables and responsibilities for closing out the actions.

The assessment and action plan shall be regularly reviewed, at least at **5-yearly intervals**, however, this should be more frequently if the conditions or layout of the workplace change in a manner that might alter the noise exposure profiles across the facility.

b) Quantitative Assessment

A qualitative risk assessment may conclude the need for detailed quantitative surveys of noise levels in the workplace. In such circumstances, full profiles of noise levels and exposures in the workplace shall be drawn from measurement of the five parameters listed in the table below.

Table 4.2.10: Sound Level Parameters [Ref. 33]

ITEM	PARAMETER MEASURED	LABEL	UNIT
1	Daily personal dose, as an 8 or 12 hr time weighted average*	Lep, d	dBA
2	Average sound level*	Leq	dBA
3	Peak sound level**	LCpeak	dBC
4	Average peak sound level**	Leq	dBC
5	Frequency analysis at locations showing sound levels above 85 dBA **(for implementing effective engineering controls)**	Octave [1/3] Band Analysis using A-filter	dBA
6	Frequency analysis at locations showing sound levels above 85 dBA (**for HPE effectiveness)**	Octave [1/1] Band Analysis using A-filter	dBA
Measurements shall be taken during typical and representative plant and operating conditions, as determined by the assessment team in discussion with site personnel. *Approximate human hearing response **For impact/impulse and engineering control measurement and effectiveness			

Note [Ref. 37]:

Lep d - is the notional A-weighted, equivalent continuous sound level which, if it occurred over the same time period, would give the same noise level as the actual varying sound level. The T denotes the time period over which the average is taken, for example Leq, 8h is the equivalent continuous noise level over an 8 hour period.

Leq - is the notional A-weighted, equivalent continuous sound level which, if it occurred over the same time period, would give the same noise level as the actual varying sound level. The T denotes the time period over which the average is taken, for example Leq, 8h is the equivalent continuous noise level over an 8 hour period.

LCpeak – C-weighted, peak sound level.

LCeq – C weighted Leq (equivalent sound level).

In addition, the following supporting information shall be gathered during the survey and recorded on a field sampling sheet:

(i) Work area, job activities / tasks, and number of personnel in each area;
(ii) Activity being measured and duration of measurement;
(iii) Work patterns (break times; work periods, shifts, etc.);
(iv) Details of existing control measures;
(v) Type of noise sources and their characteristics;
(vi) Equipment setting, calibration, and unique measurement identifier (e.g. run number);
(vii) Date & time of measurement;
(viii) Name of person conducting the survey.

Noise surveys are complex operations and are to be conducted by experienced and competent persons and it is beyond the scope of this CP to provide detailed information on measurement techniques and instrumentation. However, the following subsections provide a brief description of the types of sound level and personal dose meters that may be used to determine noise profiles in the workplace.

Octave Band Analysis shall be recorded and maintained as per **Error! Reference source not found.**.

4.2.11.INSTRUMENTATION USED FOR NOISE CALCULATION

a) Class 1 - Sound Level Meters (SLM)

Class 1 SLMs are intended for precision noise measurements and is used in field and laboratory. These are SLM whose error does not exceed ± 1 dB. **These SLMs are most preferred to be used for field measurement.**

Class 1 sound level meter are designed to meet the requirements of IEC 61672-1:2002 (or the equivalent BS EN 61672-1:2003) IEC 61672-1:2003 Class 1; Type 1 to IEC 60651, IEC 60804 and ANSI S1.4.

b) Class 2 - General Purpose Sound Level Meters (GP-SLM)

These are designed for general noise surveys and provide accurate, reliable and repeatable measurements. A non-integrating SLM provides instantaneous readings of the sound levels; however, in a workplace where the sound levels are continuously changing, it is impossible to manually average the observed readings.

All quantitative surveys shall conduct with an integrating SLM and recording the average equivalent sound levels [Leq]; Impulse sound level [LCpeak] & the average equivalent impulse sound [LCeq] values.

General purpose sound level meters are categorised as Class 2 and shall meet the following international standards: IEC 61672 Class 2; IEC 60651 and IEC 60804 Type 2; ANSI S1.4, ANSI S1.43 Type 2. Class 2 meters can also be fitted with a frequency analyzer for octave band analysis.

c) Personal Dosimeters

These are portable Class 2 SLMs capable of logging and integrating sound levels over time. Internal software records time, calculates dose, average sound, and some models also provide a graphical profile of noise levels with time.

Dosimeters provide valuable information because they continuously log noise levels as the person is moving across various areas and activities, each with their own characteristic noise profile. As a result, dosimeters provide the truest reflection of personal noise exposure for a defined activity.

0 shall be followed for records of personal noise dosimetry.Acoustic Calibrator

d) Acoustic Calibrator

Field calibration of Sound Level Meters is an essential procedure when carrying out any type of quantitative noise assessment and shall be conducted both before and after each measurement sequence. This ensures that the SLM is providing consistently accurate readings for compliance with exposure limits.

The calibrator consists of a microphone and a digital feedback loop that maintains the acoustic pressure being presented to the SLM at the required level (usually 94-114 dB, @ 1 kHz).

Calibrators rated as Class 2 (meeting the ANSI S1.40:2006 Class 2 and IEC 60942:2003 Class 2 standards).

e) Calculating Noise Exposure

Calculating noise exposure is complex but several internet-based calculators are available and these greatly simplify the process of performing daily noise exposure calculations. The most readily available is at http://www.hse.gov.uk/noise/calculator.htm. Conversion of noise decibels to doses can be done using the tool found in this link:

f) Calculation of Allowable Noise

For calculation of Noise Time Weighted Exposure, refer to ADNOC OHRM Corporate Practice HSE-OH-CP01 [Ref. 55]. The calculator tool can also be found in this link:

4.2.12.NOISE SURVEY METHODOLOGY [REF. 47]

a) Basic Sound Survey

Basic sound survey is to identify those areas where the worker TWAs are 85 dBA or higher (meeting ADNOC Noise Exposure Limit). The basic sound survey is also used to identify areas where employee TWAs are below the action level and to determine typical sound level ranges for these workstations.

The basic sound survey shall identify work areas where the sound levels could create annoyance and contribute to communication difficulties. The data collected during the basic sound survey will assist the entity / GC personnel in providing an adequate response to these and other related queries. Furthermore, this survey shall be used to establish a sound level database that can be utilized to broadly estimate TWAs for workers and / or job descriptions in order to stratify the workforce for statistical sampling purposes (i.e. to divide the workforce into groups of similar noise exposure).

It is required that all the areas at the plant site be visited during the basic noise survey, and the existing noise levels documented.

b) Detailed Sound Survey

The data collected during the basic sound survey shall identify the work areas, workstations, and/or job classifications at the plant site where more detailed sound survey information is required . A sketch or drawing of the plant facility shall be referred to during the detailed sound survey.

The purpose of the detailed sound survey is to complete the classification of the remaining areas. At the conclusion of the detailed sound survey a plant site drawing or tabulation list shall exist that defined the typical TWA ranged for all company employees.

c) Engineering Noise Control Survey

Engineering Noise Control Surveys are conducted to test the effectiveness of the controls in a noisy work area. The surveys are performed at a time when all production equipment and other noise sources can be turned off, so that the surveyor has complete control of the background sound level.

d) Conducting a Noise Survey Using SLM

The steps shall be followed for conducting Noise Survey using SLM:

(i) Prior to the sampling, the respective plot plans of the concerned locations shall be marked with grid points indicating the exact location of the proposed noise data capture.
(ii) The technician / operator shall be thoroughly familiar with operation of SLM and confirm the normal functioning of the instrument and that the battery is sufficiently charged for uninterrupted use during the sampling period.
(iii) A wind shield is used to negate effect of wind currents.
(iv) Calibration of noise measurement instruments must be checked at the beginning and end of each day's use.
(v) To obtain the most accurate data, the SLM must be mounted on a tripod and preferably positioned 1.5 meters above the floor. If the employee works in a sitting position in a particular workplace, the microphone shall be positioned at 1.1 meters above the floor. Shielding by presence of employee and other objects between the noise source and microphone shall be avoided. The operator shall be at a reasonable distance (1 m) behind the sound level meter.
(vi) For measurements around high noise sources, the SLM needs to be held 1 meter away from the source with multiple reading taken around the sources or machinery. This will provide a noise (and frequency) profile of the source.
(vii) For measurements inside buildings (e.g. for investigating a sleep disturbance), the preferred positions are at least 1m from walls or other major reflecting surfaces, 1.2m to 1.5m above the floor, and 1.5m away from windows. The presence of furnishings or other reflective surfaces, which may result in shielding or scattering of the noise, should also be considered.
(viii) Noise measurements to determine human response shall be made at the A-Weighting and slow response settings. Impulse noises are measured by using C-Weighting and fast response settings.
(ix) Octave band analysis shall be performed at noise spectral bands with centre frequencies 31.5, 63, 125, 250, 1k, 2k, 4k, 8k & 16 kHz using an Integrating Sound Level Meter
(x) Sufficient number of readings must be taken at different directions to indicate representative noise level.
(xi) Record the readings and details of calibration in the corresponding report formats along with supplementary details.

e) Conducting Personnel Noise Dosimetry

Personnel noise dosimetry devices shall be used to ascertain noise levels within the workplace. The intention is to obtain these measurements for each task carried out by each participant. In cases where it is not possible for the noise dosimeter to be worn by the participant, the noise dosimeter will need to be worn by a substitute employee who worked on the same task in the same work area in full working shift. The following steps shall be followed for conducting Personal Noise Dosimetry:

(i) Identify a noisy area and connect the audio dosimeter to an individual.
(ii) Dosimeter shall be attached to the worker's hearing zone and participants shall be instructed to carry out their usual tasks. Dosimeters shall be worn by the noise-exposed worker during the entire duration of the work shift and shall not be tampered with.
(iii) Read the measurement and record data.
(iv) Complete a field monitoring data form, remembering to record surveyor name, facility and location monitored, date, air temperature, air pressure, relative humidity, and audio dosimeter and calibrator manufacturer and model.

A Hearing Conservation Program (HCP) must be developed for each facility where high or medium risks of Noise-Induced Hearing Loss (NIHL) have been identified. It is an integrated set of actions covering monitoring of exposure; provision of control measures; assessment of the efficacy of control measures (including HPD); training; health surveillance and traceable and auditable record keeping.

(i) A Hearing Conservation Programme shall ensure that the following tasks are carried out:
(ii) A competent & detailed noise exposure survey is conducted regularly. Surveys should also be conducted when new equipment or working procedures are implemented;
(iii) Controls are introduced to reduce noise exposure to ALARP;
(iv) Adequate instruction, information and training are provided to ensure that personnel understand the consequences of high noise exposure & cooperate with the programme;
(v) Records of surveys and actions are maintained to demonstrate compliance with this Corporate Practice; and

Adequate health surveillance programmes are coordinated between occupational health practitioners, physicians, HSE engineers and employees in the medium risk or higher SEG categories. Appropriate audiometric testing shall be conducted among these noise exposed workers. ADNOC Hearing Conservation Programs shall consist of the following elements:

a) Exposure Monitoring

(i) ADNOC Group shall use a competent person to develop and implement a monitoring program and sampling strategy to assess employee's exposure to noise;
(ii) The sampling strategy shall be designed to identify employees for inclusion in the hearing conservation program and to enable the appropriate selection of hearing protection;
(iii) Where circumstances such as high employee mobility, significant variations in sound level, or a significant component of noise make area monitoring inappropriate, the ADNOC Group shall use representative personal sampling to comply with the monitoring requirements;
(iv) All continuous, intermittent and impulse sound levels from 85 dB(A) and above shall be integrated into the noise measurements;
(v) Instruments used to measure employee noise exposure shall be calibrated as per manufacturer's recommendations to ensure measurement accuracy;
(vi) Monitoring shall be repeated whenever a change in production, process, equipment or control measures increases noise exposures to the extent that:

- Additional employees may be exposed at or above the action level; or
- The attenuation provided by hearing protectors being used by employees may be rendered inadequate to meet the requirements of this Corporate Practice.

b) Employee Notification

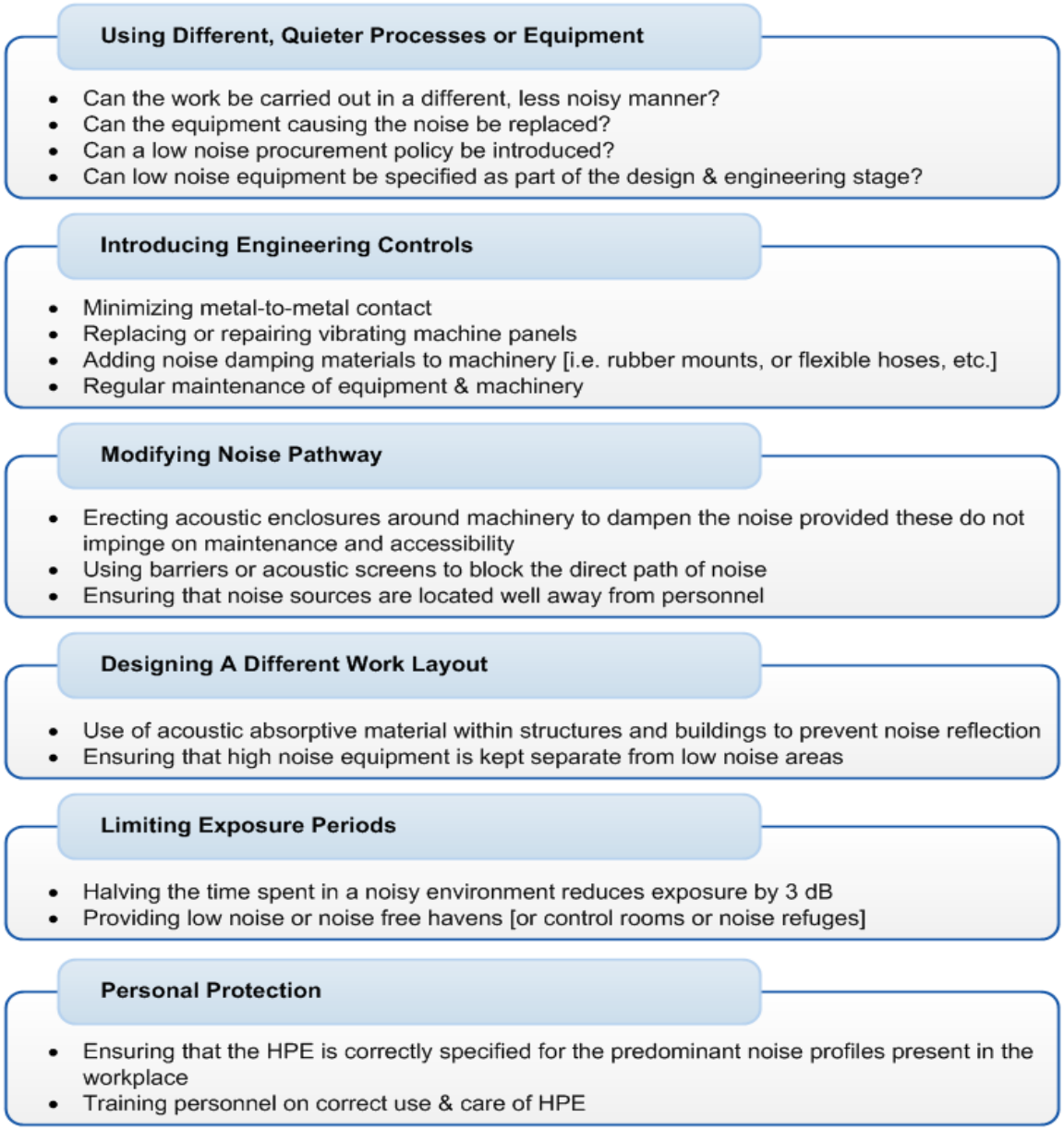
ADNOC Group shall notify each employee exposed at or above an **8-hour time-weighted average of 85 dB (A)**. Notification shall be made in the language and method understood by the employee.

c) Control of Risks

Reducing workplace noise and minimizing exposure can be achieved using several methods; but as a rule, effective noise control shall be based on applying a combination of solutions described in the Hierarchy of Control [Ref. 55].

The principal objective in noise control programs shall be to eliminate high noise at source, thus preventing exposure from occurring in the first place. However, if this cannot be practically achieved, consideration shall be given to a combination of solutions based on the approaches outlined in the following Figure.

Figure 4.2.12: Noise Reduction in the Workplace


Using Different, Quieter Processes or Equipment
Can the work be carried out in a different, less noisy manner?
Can the equipment causing the noise be replaced?
Can a low noise procurement policy be introduced?
Can low noise equipment be specified as part of the design & engineering stage?
Introducing Engineering Controls
Minimizing metal-to-metal contact
Replacing or repairing vibrating machine panels
Adding noise damping materials to machinery [i.e. rubber mounts, or flexible hoses, etc.]
Regular maintenance of equipment & machinery
Modifying Noise Pathway
Erecting acoustic enclosures around machinery to dampen the noise provided these do not impinge on maintenance and accessibility
Using barriers or acoustic screens to block the direct path of noise
Ensuring that noise sources are located well away from personnel
Designing A Different Work Layout
Use of acoustic absorptive material within structures and buildings to prevent noise reflection
Ensuring that high noise equipment is kept separate from low noise areas
Limiting Exposure Periods
Halving the time spent in a noisy environment reduces exposure by 3 dB
Providing low noise or noise free havens [or control rooms or noise refuges]
Personal Protection
Ensuring that the HPE is correctly specified for the predominant noise profiles present in the workplace
Training personnel on correct use & care of HPE

Hearing Protection

Hearing Protection Device [HPD] is extensively discussed in the ADNOC Personal Protective Equipment Corporate Practice HSE-PSW-CP17. Use of Hearing Protection Device [HPD] is considered to be the last resort of controlling noise exposure, and it also should not be used as an alternative to the implementation of correct, well-designed engineering, administrative and technical measures.

d) Information, Training and Instruction

The entity is required to ensure personnel exposed to noise receive appropriate information instruction and training in noise risks and to understand how to use control measures.

4.2.13.HEALTH SURVEILLANCE

The respective entity will be required to ensure health surveillance is completed for personnel exposed to significant noise levels. Health surveillance is required when the risk assessment indicates a risk to the worker's health and must be instituted for workers who are regularly exposed to noise levels. Additionally, any employee complaints or Noise Induced Hearing loss-related symptoms is to undergo thorough medical evaluation by the licensed healthcare provider.

A Noise Health Surveillance Questionnaire can be found in the ADNOC Health Screening and Surveillance Corporate Practice HSE-OH-CP07

4.2.14.COMPLIANCE / ASSURANCE

Assurance and compliance auditing of noise management shall be considered and implemented.

4.2.15.HEARING PROTECTION ZONES

Where it is not reasonably practicable to mark hearing protection zones (e.g. where noise sources are mobile), the ADNOC Group shall provide suitable alternative arrangements to ensure that employees know where and when protection shall be worn. These shall include:

(i) Attaching signs to tools instructing users to wear hearing protection; or
(ii) Providing written and verbal instructions on how to recognise where and when protection shall be worn.

Noise risk assessments shall identify areas or activities where employees are likely to be exposed to high or medium risks of NIHL. In such cases, the company is required to identify these areas / activities as 'mandatory hearing protection zones' as well as to ensure that employees, contractors, or visitors do not enter these areas or conduct these activities without wearing the correct HPE.

Hearing protection zones / activities should be marked with a sign (see examples in **Error! Reference source not found.** indicating where HPE is mandatory). The signs are to be located at all entrances to the zones and at other appropriate places within the zones as deemed necessary.

Figure 4.2.13: Mandatory Hearing Protection Zones

Note: Consider the delineation of single vs. double hearing protection zones: 85 dB (A) for an 8-hour shift will be the minimum threshold limit for a single hearing protection device (83.2 dBA for 12 hour shift as provided by the equation: Limit for a given shift = L exposure limit - 10 log (T/8), where T is duration of work shift in hours). When sound levels reach 100 dB (A), double hearing protection (i.e. earplugs and earmuffs) devices are required.

4.3. VIBRATION

Vibration is the result of mechanical oscillation of an object about an equilibrium point. The oscillations may be regular [e.g. a pendulum movement] or random [e.g. the movement of a machine, or tyre on a gravel road]. Any vibration has three measurable quantities that determine its vibrational characteristics. These are described below and demonstrated graphically in Figure 4.3.1.

1. Amplitude

   This is the movement of an object to a certain maximum distance on either side of its stationary [central] position. Amplitude is the distance from the stationary position to the extreme position on either side and is measured in metres (m). The intensity of vibration depends on amplitude.

2. Frequency

   A vibrating object moves back and forth from its normal stationary position. A complete cycle of vibration occurs when the object moves from one extreme position to the other extreme and back again. The number of cycles that a vibrating object completes in one second is called frequency. The unit of frequency is hertz (Hz). One hertz equals one cycle per second.

3. Acceleration (Vibration Intensity)

   The speed of a vibrating object varies from zero to a maximum during each cycle of vibration. It moves fastest as it passes through its natural stationary position to an extreme position. The vibrating object slows down as it approaches the extreme, where it stops and then moves in the opposite direction through the stationary position toward the other extreme. Speed of vibration (acceleration) is expressed in metres per second (m/s) and acceleration is expressed in meters per second squared (m/s2).

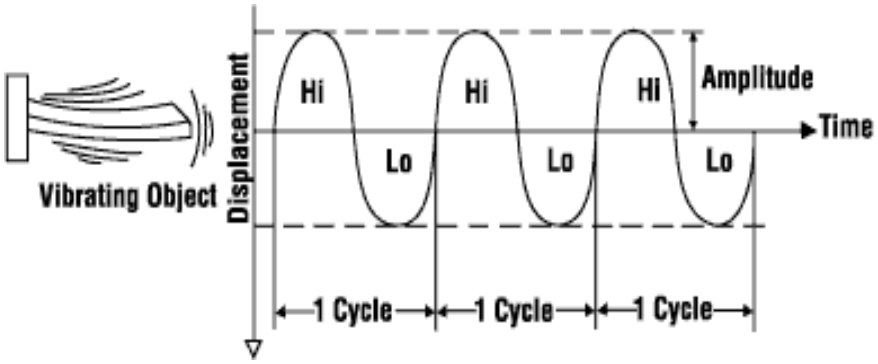


Figure 4.3.1: Graphical Demonstration of Vibration Characteristics [Ref 45] RECOGNITION of Vibration Hazard

4.3.1. COMPETENCE

The entity shall assign suitably qualified and competent personnel for management of vibration exposure and risks. The competent person(S) shall have the relevant certification to perform vibration assessment and control

4.3.2. HEALTH EFFECTS OF VIBRATION

Vibration impacts the body part that is in contact with the vibrating equipment. When a worker operates a hand-held power tool, such as a chain saw, a grinder or jackhammer, vibration affects the hands and arms. This type of exposure is called **hand-arm vibration**. On the other hand, when a worker sits or stands on a vibrating floor or the seat of moving vehicle or crane, the vibration exposure affects almost the entire body and is called whole body vibration exposure.

The risk of vibration-induced injury depends on the average daily exposure. Hand-arm vibration causes damage to hands and fingers and especially to its blood vessels and nerves. The resulting condition is known as **white finger disease, Raynaud's phenomenon** or **Hand-Arm Vibration Syndrome (HAVS)**. One of the symptoms is that affected fingers may turn white especially when exposed to cold, a loss of grip force and sensitivity to touch.

Vibration-induced white finger (VWF) is the most common occupational health condition among operators of hand-held vibrating power tools. The symptoms of VWF are aggravated when the hands are exposed to cold temperatures.

Vibration can also cause changes in tendons, muscles, bones and joints, and can affect the nervous system. Collectively, these effects are known as Hand-Arm Vibration Syndrome (HAVS). HAVS develop gradually and increases in severity over time; hence it may take a few months to several years for the symptoms to become clinically noticeable.

Nonetheless, workers affected by HAVS commonly report the following symptoms:

i. Attacks of whitening (blanching) of one or more fingers when exposed to cold;
ii. Tingling and loss of sensation in the fingers;
iii. Loss of light touch;
iv. Pain and cold sensations between periodic white finger attacks;
v. Loss of grip strength; and
vi. Bone cyst in fingers and wrists [Ref. 21];
vii. Health Effects such as: Lower back pain (damage to vertebrae and discs, ligaments loosened from shaking), Motion sickness, Bone damage, varicose veins/heart conditions (variation in blood pressure from vibration).

Whole body vibration can cause fatigue, insomnia, stomach problems, headache and "shakiness" shortly after or during exposure. After daily exposure over a number of years, whole body vibration can affect the entire body and result in a number of health disorders. The table below summarizes the effects of whole-body vibration at different frequencies:

Vibration Frequency	Health Effects
Low Frequency Vibration (0 – 2 Hz)	Motion sickness, visual effects, conflicting information within vestibular system and between visual and vestibular systems
Middle Frequency Vibration (2 – 30 Hz)	Resonance in thoracic-abdominal system, neck problems, blurred vision, decrease in spine disc nutrition, decrease in spine disc fluid content

Jobs & Tools Linked To Vibration Risks

Hand Arm Vibration:

i. Jobs include: building maintenance; ground maintenance; gardening; motor vehicle repair; tyre changing; fabrication;
ii. Tools include: chainsaws; concrete and road breakers; cut off saws; hand drills; jack hammer, radial drill, hammer drills; impact wrenches; compaction machine; jigsaws; needle scalers; powered lawn mowers; hedge trimmers; strimmer; power sanders.

Whole Body Vibration:

iii. Jobs include: gardening; civil works; transportation & warehousing;
iv. Vehicles include: sit on lawn mowers; tractors; heavy road vehicles; and heavy duty forklift trucks, excavator and skid steer loader and bulldozer.

4.3.3. VIBRATION MEASUREMENT METHODOLOGY

The purpose of the Vibration Monitoring Methodology is to enable managers to make a valid decision about the measures necessary to prevent or adequately control the exposure of employees to HAV or WBV. It also enables managers to demonstrate readily to others who may have an interest, e.g. employees, safety representatives and enforcement authorities that they have from the earliest opportunity considered the risks from vibration.

Generally , the following steps shall be followed:

i. Identifying all existing powered tools, equipment, machinery and vehicles which potentially pose a risk of hand arm vibration or whole body vibration.

ii. Reviewing and observing the conditions under which such powered tools, equipment and machinery are used to obtain a true and representative appreciation of the nature of the work
iii. Identifying the maximum duration of their use ('trigger time' for HAVS or work time for WBV) in any working day, if necessary, by keeping a log or using monitoring devices
iv. Assessing the vibration magnitude from each piece of equipment used. This information must be provided by the manufacturer: however, it is important to take into consideration that manufacturers' data will often come from testing under specific controlled conditions which are very different from normal working practices and therefore may significantly underestimate exposures in practice.
v. Additional information from on-site measurement or from databases of vibration levels should be considered as necessary.

Refer to Figure 4.3.1 for specific instructions on how to measure hand arm vibration levels from various hand-powered tools. For detailed guidance, please refer to the document Mechanical vibration - Measurement and evaluation of human exposure to hand-transmitted vibration, Part 2: Practical guidance for measurement at the workplace, BS EN ISO 5349.2- 2013, ISO 5349:2:2001 [Ref. 45].

4.3.4. RISK ASSESSMENT

Entities will be required to complete qualitative and / or quantitative vibration risk assessment(s) to assess risk to personnel. Risk assessment and exposure monitoring is to be undertaken in line with the local regulatory requirement and best international practices.

It is required for entities to follow the applicable standards and legislation deemed fit for the purpose for conducting vibration assessment. Vibration exposures should be re-assessed as required to evaluate the effectiveness of existing controls or to determine the need for further controls base on risk level.

a) Qualitative Assessment

ADNOC Group and Contractors will be required to carry out risk assessments where there is the likelihood of an employee being exposed to vibration at or above any of the levels cited in OHRM Corporate Practice (HSE-OH-CP01). The target of the risk assessment is to identify what actions are to be taken to ensure that the risks to health are eliminated or minimised. The ADNOC Group should also recognise that the scope of the risk assessment is wider than the simple task of taking measurements, since in some cases these may not be needed.

The targets of the risk assessment shall be to:

i. Identify where there may be a risk from vibration exposure and who may be at risk;
ii. Provide a reliable estimate of exposure and a comparison of this against the set limits (refer to Note);
iii. Identify what actions need to be taken to control exposure, based on the hierarchy of control; and
iv. Profile groups of personnel who are at high medium to high risk for inclusion in a health surveillance programme.

Note: Estimating exposure to vibration can be gained from (a) whether workers are showing any symptoms of HAV or WBV; (b) equipment of vehicles that are demonstrably producing high levels of vibration; and (c) manufacturer or technical references providing warning about certain equipment.

It is required that the assessment and results be recorded and should contain a plan showing prioritised actions for dealing with high medium and high risks, as well as include a timed schedule of actions / deliverables and responsibilities for closing out the actions.

The assessment and action plan shall be regularly reviewed, at least at 5-yearly intervals based on Qualitative OHRA methodology [Ref. 55], but more frequently if the conditions or the equipment / tools have changed or if new ones are introduced in a manner that might have altered the vibration exposure profiles across the facility.

1. Assessing Hand Arm Vibration

Conducting HAV risk assessments should be based on a good knowledge / understanding of the work processes used at the facility, as well as the ability to collect and understand relevant information and tool specifications. To conduct an adequate HAV risk assessment, the following tasks should be considered:

I. Develop a list of SEGs who use the equipment and what jobs they carry out. It is critical to accurately estimate how long the employee's hands are in contact with the equipment while it is vibrating. This is known as the 'trigger time' and can vary widely between a few minutes and several hours; and a Register should be compiled of all power tool . The Register is to include the following:

- Tool name, model, serial number, and age [period being in use];
- Activity, their risk category and location of use;
- Maintenance details; and
- Vibration characteristics, particularly vibration equipment acceleration levels [usually available from manufacturer or in tool technical data sheet].Face-to-face interviews with employee SEGs shall be conducted to establish which equipment is anticipated to have high levels of vibration and to clarify whether there are any other problems associated with the user working on the equipment (e.g. user weight, awkward postures, difficulty in holding and operating the tool); and
- Personnel and work activities shall be grouped according to whether they fall in the medium or high-risk categories. A rough grouping should be prepared using the following basic guidelines:

Table 4.3.4.1: Exposure Risk Categorization

HIGH RISK CATEGORY (I.E. EXPOSURE LIKELY TO BE > EXPOSURE LIMIT VALUE)	MEDIUM RISK CATEGORY (I.E. EXPOSURE LIKELY TO BE > EXPOSURE ACTION VALUE)
Personnel Who Regularly Operates:	**Personnel Who Regularly Operates:**
Hammer Action Tools > 1 hour per day	Hammer Action Tools > 15 minutes per day
Rotary and other Tools > 4 hours per day	Rotary and other Tools > 1 hour per day

2. Assessing Whole Body Vibration

`Conducting WBV risk assessments should be based on a good knowledge / understanding of the work processes used at the facility, and the ability to collect and understand relevant information and tool specifications. To conduct an adequate WBV risk assessment the following characteristics is to be considered:

i. Do the machinery or vehicle manufacturers warn of risks from WBV?
ii. Are the machines or vehicles unsuitable for the tasks for which they are being used?
iii. Are operators and drivers using poor techniques (e.g. driving too fast or operating the machine too aggressively; operating or driving for several hours a day)?
iv. Are employee being jolted or continuously shaken, rising visibly in the seat during operation of the machinery or vehicles?
v. Are employee reporting back or other health problems?
vi. A Register to be compiled of all heavy vehicles used having a potential for WBV. The Register must include:
    - Manufacturer & registration plate details
    - Activity, and location of use;
    - Approximate period of use [work time];
    - Maintenance / servicing details; and
    - Vibration characteristics [usually available from manufacturer]

a) Quantitative Assessment

The qualitative risk assessment may conclude the need for detailed quantitative surveys of vibration exposures in the workplace. In such circumstances, evaluation of exposure to HAV should be done using the method defined in BS EN ISO 5349-1:2001 on Mechanical Vibration. In summary, vibration is measured with a triaxial sensor (transducer) which can be attached to a tool; or else it is placed on the seat of the vehicle and is known as a seat accelerometer.

A triaxial sensor is used because damage caused by vibration transmitted through the hand or the body, is related to the averaged magnitude of acceleration in the three axes x, y, and z. For hand arm vibration, the acceleration levels in three orthogonal axes [the x axis, y axis and z axis at right angles to each other] are squared and summed to give the Vibration Total Value, ahv. The formula for ahv is:

ahv = $\sqrt{}$ (a2hwx+a2hwy+a2hwz); where ahwx , ahwy, ahwz are the root mean square acceleration magnitude measured in three orthogonal directions x, y & z at the vibration surface in contact with the hand ahv is the measured vibration magnitude in m/s2

The measurements of WBV are presented as separate averages for each of the x-, y- and z-axes. The values for the x- and y-axes (Wd) are then multiplied by a factor (k) of 1.4, while the values for the z-axis (Wk) are multiplied by a factor (k) of 1.0 (i.e. they stay the same).

The average whole-body vibration level is then taken as the highest of the values in the three axes (including the multiplication factors).

The resultant levels are then compared with the EAV and the ELV for whole-body vibration to test whether action is required to reduce the operator's vibration exposure. Measurement should be taken during typical and representative plant and operating conditions, as determined by the assessment team in discussion with site personnel.

In addition, the following supporting information should be gathered during the survey and recorded on a field sampling sheet:

i. Work area, job activities / tasks, and number of personnel in each area;
ii. Activity being measured and duration of measurement;
iii. The work patterns [break times; work periods, shifts, etc.];
iv. Details of existing control measures;
v. Type of vibration sources and their characteristics;
vi. Equipment settings, calibration, and unique measurement identifier [e.g. run number];

vii. Date & time of measurement; and
viii. Name of person conducting the survey.

3. Evaluation of Vibration Exposure

ADNOC Group and Contractors are required to comply with controlling vibration at work through elimination or minimisation of exposure to all types of vibration to below the Action Values and Limits tabulated below. These requirements are based on UK HSE Control of Vibration at Work regulation. The Action and Limit Values are tabulated in the following Table 4.3.4.2.

Table 4.3.4.2: Vibration Action and Limit Values [Ref. 41].

VALUES	HAND ARM VIBRATION DAILY EXPOSURE, A(8), M/S^2	WHOLE BODY VIBRATION DAILY EXPOSURE, A(8), M/S^2
Exposure Action Value, (at which ADNOC Group shall introduce technical and organizational measures to reduce exposure)	2.5	0.5
Exposure Limit Value, which shall not be exceeded at any time	5.0	1.15
Note: A (8) - Daily vibration exposure A (8) means the quantity of HAV a worker is exposed to during a working day, normalised to an eight hour reference period, which takes account of the magnitude and duration of vibration. Daily vibration exposure is derived from the magnitude of the vibration (vibration total value) and the daily exposure duration.		

- Hand Arm Vibration
  The TLV for vibration levels in terms of exposure time can be found in the ACGIH TLV and BEI booklet.
- Whole Body Vibration
- Refer Table 4.3.4.2 for allowable weighted acceleration limits vs. exposure duration

4.3.5. CALCULATING VIBRATION EXPOSURE

Calculating vibration exposure is complex but several internet-based calculators are available, and these greatly simplify the process of performing daily vibration exposure calculations. The most readily available is:

The **hand arm vibration calculator** can be used using the link provided below:

https://www.hse.gov.uk/vibration/assets/docs/simple-hav.xlsx

- The calculator is a spreadsheet file (Microsoft Excel) which may be downloaded and saved on your computer.
- Click on the white areas and enter a representative vibration magnitude (in m/s2) and an exposure duration (in hours and / or minutes).
- The following values will then be calculated and displayed in the yellow cells on the right:
  - **Partial exposure (**shown in both m/s2 A(8) and exposure points) for each tool or process, as calculated from the vibration magnitude and the exposure duration.

- **Daily exposure**, also in m/s2 A(8) and exposure points, as calculated from the partial exposures.
- **Exposure points per hour.** The number of exposure points corresponds to every hour of exposure time for the individual machine or process.
- **Time to reach EAV** (exposure action value). This is the total exposure time required for the individual machine or process, before the EAV (2.5 m/s2 A(8) or 100 points) is reached.
- **Time to reach ELV** (exposure limit value). This is the total exposure time required for the individual machine or process, before the ELV (5 m/s2 A(8) or 400 points) is reached.
- The cells can be cleared for another calculation by clicking on the Reset Options in the bottom left-hand corner.

The **whole body vibration calculator** can be used using the link provided below:

http://www.hse.gov.uk/vibration/wbv/calculator.htm

1. The calculator is a spreadsheet file (Microsoft Excel) which may be downloaded and saved on your computer.
2. Click on the white areas and enter a representative vibration magnitude (in m/s2) for the x, y, and z axes and an exposure duration (in hours and/or minutes).
3. The following values will then be calculated and displayed in the yellow cells on the right:
   - **Partial daily vibration** exposures (shown in m/s2 A(8)) for x, y and z axes, as calculated from the vibration magnitude and the exposure duration.
   - **Total A(8) exposures** for x, y and z axes
   - **Daily exposure,** also in m/s2 A(8), as calculated from the partial exposures.
4. The cells can be cleared for another calculation by clicking on the Reset Options in the bottom left-hand corner.

4.3.6. CONTROL OF RISKS

Entities are required to ensure suitable and appropriate controls, considering the hierarchy of risks control [Ref. 55] are identified, implemented and acceptable. These controls are to be maintained and tested appropriately and kept in good condition.

a) Using the Risk Assessments

The information gathered during the qualitative / quantitative risk assessments should be utilized to achieve the following tasks:

i. Task 1: Identifying high medium or high risk SEGs exposed to high levels of vibration, and pinpointing work activities classified to be of high medium and high risks to vibration;
ii. Task 2: identifying what measures will practically control vibration exposure; what level of vibration reduction can realistically be achieved; and whether these measures are considered to be ALARP;
iii. Task 3: establishing priorities and a timetable for implementing the actions. This task shall be used to establish what long-term changes are necessary, what benefits will be gained; and how many people will be impacted by the changes;
iv. Task 4: assigning roles and responsibilities for implementing the action plan; and
v. Task 5: monitoring, reviewing and assessing the effectiveness of the action plan.

b) Reducing Vibration

Reducing vibration risks in the workplace and minimising exposure shall be achieved using several methods, but as a rule effective vibration control is based on applying a combination of solutions described in the Hierarchy of Controls [Ref. 55].

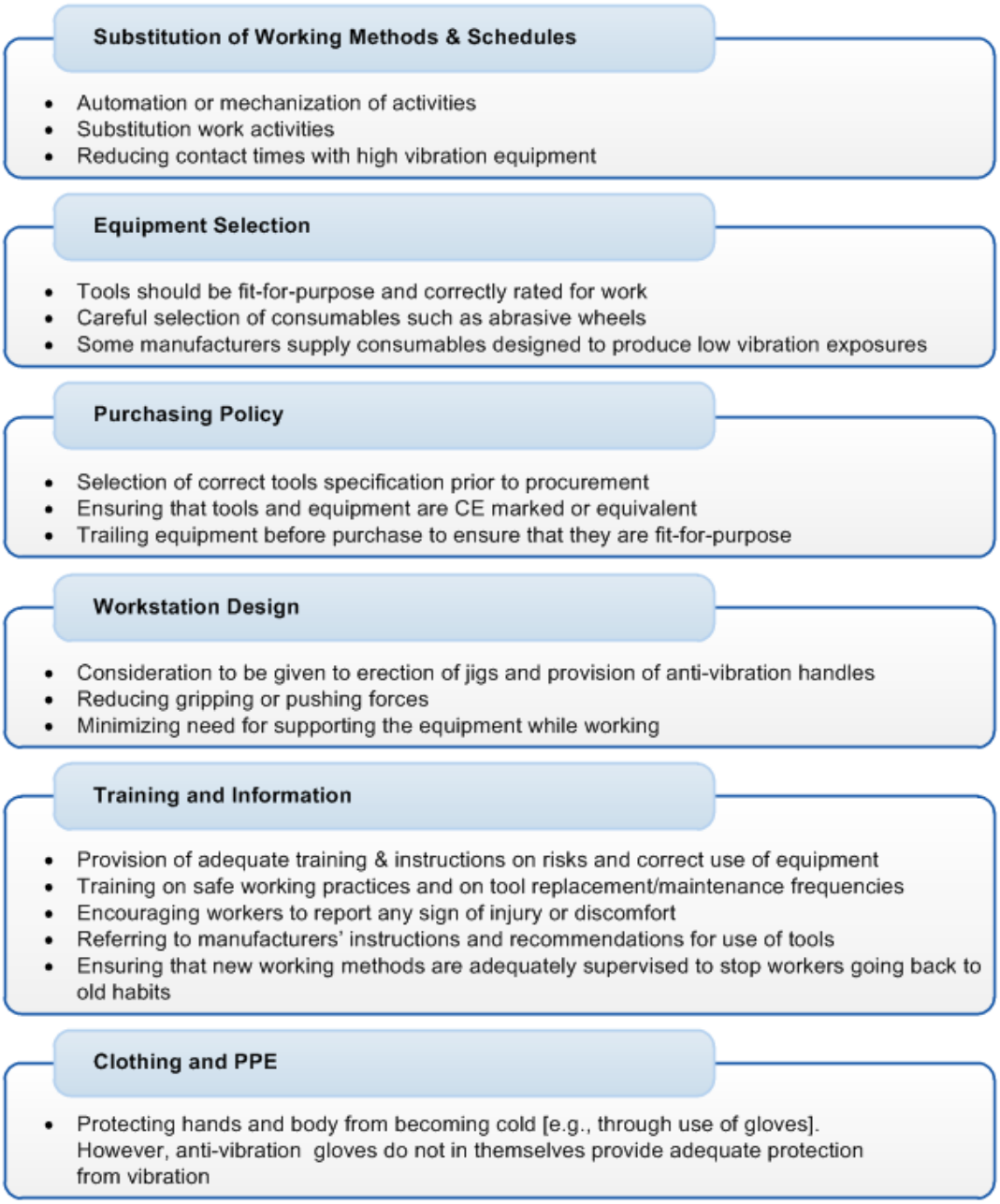

Substitution of Working Methods & Schedules
Automation or mechanization of activities
Substitution work activities
Reducing contact times with high vibration equipment
Equipment Selection
Tools should be fit-for-purpose and correctly rated for work
Careful selection of consumables such as abrasive wheels
Some manufacturers supply consumables designed to produce low vibration exposures
Purchasing Policy
Selection of correct tools specification prior to procurement
Ensuring that tools and equipment are CE marked or equivalent
Trailing equipment before purchase to ensure that they are fit-for-purpose
Workstation Design
Consideration to be given to erection of jigs and provision of anti-vibration handles
Reducing gripping or pushing forces
Minimizing need for supporting the equipment while working
Training and Information
Provision of adequate training & instructions on risks and correct use of equipment
Training on safe working practices and on tool replacement/maintenance frequencies
Encouraging workers to report any sign of injury or discomfort
Referring to manufacturers' instructions and recommendations for use of tools
Ensuring that new working methods are adequately supervised to stop workers going back to old habits
Clothing and PPE
Protecting hands and body from becoming cold [e.g., through use of gloves]. However, anti-vibration gloves do not in themselves provide adequate protection from vibration

Figure 4.3.6: Suggestions for Vibration Reduction in the Workplace

The principal objective is to eliminate vibration at the source, thus preventing exposure from occurring in the first place. However, if this cannot be practically achieved, consideration shall be given to a combination of solutions based on the approaches outlined in Figure 4.3.6.

c) Maintenance

The following tasks shall be regularly applied, as deemed appropriate for the facility / activity:

i. Cutting tools and drills are to be kept sharp;
ii. Grinding wheels to be correctly dressed [i.e. set and aligned] as per the manufacturer's recommendations;
iii. All moving parts are to be lubricated in accordance with manufacturer's recommendations;

iv. Worn parts are to be replaced;
v. Necessary balance checks and corrections are to be carried out;
vi. Anti-vibration mounts and suspended handles are to be replaced before they deteriorate. Signs of deterioration often include cracking, swelling and softening, or hardening of rubber mounts;
vii. Defective vibration dampers, bearings and gears are to be replaced;
viii. Chainsaw teeth are to be regularly sharpened, and the correct chain tension shall be set;
ix. Vehicle motors & engines are to be tuned; and
x. Damaged seats and shock absorbers on vehicles are to be replaced.
xi. The following control measures are applicable for whole body vibration exposures [Ref. 67, 68]:
xii. Design and construct vehicles and machines which reduce whole-body vibration to the minimum that can be achieved
xiii. Train and instruct operators and drivers
xiv. Select vehicles and machines with the appropriate size, power and capacity for the work and the ground conditions
xv. Make sure that paved surfaces or site roadways are well maintained, e.g. potholes filled in, ridges levelled, rubble removed.
xvi. Maintain vehicle suspension systems correctly (e.g. cab, tyre pressures, seat suspension).
xvii. Sufficient and easy adjustment of the seat for height, backrest and seat position and which will suit a wide range of driver sizes;

4.3.7. HEALTH SURVEILLANCE

Entities must ensure that health surveillance is conducted for personnel exposed to levels above the allowable threshold(s). Health surveillance is also, required when the risk assessment indicates a risk to the worker's health and must be instituted for workers who are regularly exposed to vibration levels above the EAV. This involves administering relevant questionnaires during physical examinations along with the minimum investigations. Additionally, an employee from the relevant worker SEG having complaints or HAV or WBV-related symptoms will undergo thorough medical evaluation by the licensed healthcare provider.

A Hand Arm/Whole Body Vibration Health Surveillance Questionnaire can be found in the ADNOC Health Screening and Surveillance Corporate Practice HSE-OH-CP07.

4.3.8. ASSURANCE / COMPLIANCE

Assurance and compliance auditing of vibration risk management should be considered and implemented.

4.4. HEAT STRESS

Working in hot environments, whether these are man-made (e.g. working near hot surfaces) or natural (i.e. summer climate, sunshine, hot winds, or dry desert conditions) puts people under extreme thermal stresses that can have serious consequences on their health and safety.

The human body is at optimum comfort when its core temperature is maintained between 36°C-37.5°C. If the core temperature increases by more than 1°C, the body is either suffering from an infection that is causing a fever; or else it is unable to deal with the heat in the surrounding environment.

A normal body exchanges heat in several ways as shown below in Figure 4.4.1. If all the elements balance out, the body does not store heat; but if they do not the body either loses (i.e. feels cold) or gains heat (i.e. feels hot). Either situation can potentially have serious health effects on the human body.

Tiredness, dehydration, overweight, physical fitness, and the calorific content of diet can all have an effect on the body's ability to exchange heat. However, the physical demands of activities being carried out, whether these are work-related or leisure, rest periods, and general acclimatisation to the conditions also play important roles in the body's ability to exchange heat.

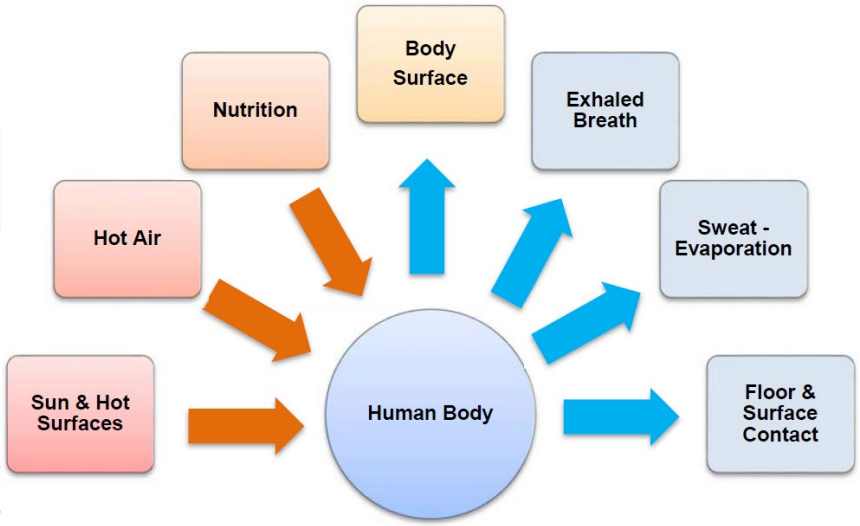


Figure 4.4.1: Heat Exchange Patterns in the Human Body

4.4.1. HEAT & HUMAN HEALTH

The amount of heat in any environment is dependent on four critical parameters; these are (a) Ambient air temperature; (b) Humidity; (c) Air Movement; and (d) Presence of Radiant or Conducting Objects in the immediate vicinity.

When the body cannot balance its temperature between 36°C - 37.5°C, one of the following progressive symptoms can occur, unless adequate controls are in place.

Table 4.4.1: Severity of Heat Symptoms

	Condition	Description
Severity of Symptoms	Heat Rash	Also known as 'prickly heat' and is a skin irritation caused by excessive sweating for a long period. The condition is manifested as a cluster of pimples or small blisters and is more likely to occur on the neck and upper chest, groin, and in elbow creases.
	Heat Cramps	These usually affect workers who have sweated for prolonged periods during strenuous activities. The sweating depletes the body electrolytes and moisture, thus causing muscles to cramp with associated pain. Spasms are often in the abdomen, arms and legs.
	Heat Syncope	This is an episode of light headedness, fainting, or dizziness, which occurs with prolonged standing or rising from a sitting or lying position. Syncope is associated with dehydration and lack of adequate acclimatization.
	Heat Exhaustion	This is the body's response to excessive loss of water and electrolytes through prolonged sweating. Symptoms include heavy sweating, fatigue, weakness, nausea, muscle cramps, flushed or pale complexion, elevated body temperature, moist skin, and shallow and fast breathing. People prone to exhaustion are the elderly, people suffering from hypertension, and workers in hot environments.
	Heat Stroke	The most serious of heat-related disorders and occurs when the body can no longer control its core temperature. Thus, body temperature rises rapidly to over 40°C within 10-15 minutes and sweating stops. Symptoms include hot dry skin, hallucinations, chill, headaches, confusion/dizziness, and slurred speech. Heat stroke can cause death or permanent disability if emergency treatment is not administered.

(a) What is Heat Stress?

Heat stress occurs when the body builds up more heat than it can handle. The early signs of employee heat illness are mild dizziness, fatigue, irritability, decreased concentration and impaired judgment. The employee may also be experiencing heat cramps, painful spasms of the leg, arm or abdominal muscles, heavy sweating and thirst. Other common heat-related illnesses include heat strain, heat exhaustion and heat stroke. Heat strain is a general term for how the body responds to heat stress.

(b) Heat Stress Measurement Methodology

Thermal Work Limit readings have to be referred from the heat stress equipment used in the respective Group Company sites/facilities. Once thermal work limit reaches below 115 W/m2 (High Risk), the use of Heat Stress Index is recommended. Heat stress index where it reaches 100% as upper limit of safety (i.e., Heat Index = 54), the outdoor work shall be suspended; and appropriate work-rest regimen shall be applied. Further details shall be discussed in Section 4.4.3.

4.4.2. COMPETENCE

Assign suitably qualified and competent personnel for the management of thermal stress environment and associated risks. Qualified and competent personnel shall have successfully completed at least the Heat Stress Awareness CBT training, and the British Occupational Hygiene Society Module 502: Thermal Stress

4.4.3. RISK ASSESSMENT

a) Qualitative Assessment

ADNOC Group and Contractors are required to carry out risk assessments where there is the likelihood of an employee or group of workers being exposed to thermal environments, whether natural or manmade.

The aim of the risk assessment shall be to identify what actions be taken to ensure that the risks to health are eliminated or minimised.

The objectives of the risk assessment shall be to:

i. Identify the high medium to high risk SEGs who are exposed to high heat stress environments;
ii. Provide a reliable estimate of exposure to thermal environments and a comparison of this against the TWL and heat index; and
iii. Identify what actions need to be taken to mitigate the effects of heat stress.
iv. The framework for carrying out risk assessments is detailed in ADNOC OHRM Corporate Practice HSE-OH-CP01 [Ref. 55]. In that respect, assessment shall be carried out by competent personnel and that the information collected during the assessment shall be reliable and reflective of the current plant and operating conditions.

b) Quantitative Assessment

The qualitative risk assessment may conclude the need for detailed quantitation of the ambient thermal parameters in the workplace. To quantitatively determine TWL, four parameters shall be measured, as below:

- Dry bulb temperature, in degrees Celsius
- Wet bulb temperature, in degrees Celsius
- Globe temperature, in degrees Celsius
- Wind speed, in meters per second

Thermal Work Limit (TWL) is the maximum sustainable metabolic rate that hydrated, acclimatized individuals can maintain in a specific thermal environment, within a safe deep body core temperature of < 38.2°C, and a sweat rate of <1.2 kg/hr-1.

Measurements shall be taken at various fixed locations around the facility, but mainly where the initial assessment has identified areas of medium or high risk SEGs to heat stress, or sources of radiant or reflected heat (e.g. boilers, hot pipelines, furnaces; heat exchangers, confined spaces, deep excavation sites, etc.).

Several instruments are commercially available in the UAE to conduct the TWL measurements, and most of these provide direct readouts of TWLs. Alternatively, measurements of the individual thermal

parameters include using conventional instruments [e.g. WBGT instruments, or appropriate thermometers and air velocity meters].

For UAE conditions, TWL (in W/m2) values fall into the following three principal categories:

i. **Green Zone** (TWL: 140 - 220< W/m^2), classified as a low risk, unrestricted zone, where there are no work limits on self-paced work for educated, hydrated workers;
ii. **Amber/Orange Zone** (TWL: 115 - 140 W/m^2), classified as a medium risk, cautionary zone and indicating the presence of situations where the prevailing environmental conditions require additional precautions to be taken; and
iii. Red Zone (TWL: <115 W/m^2), classified as a high risk zone in which strict work and rest cycles are necessary.

The values provide a measure of the maximum safe work rates for the prevailing environmental conditions. Hence, if TWL is too low, even low rates of work cannot safely be carried out continuously.

When TWL reading at red zone, **Heat Index monitoring** should be conducted and the following risk control measure should be implemented. A **heat stress index** is a single number that attempts to reflect the effects of basic parameters in any thermal environment. It aims to correlate the number with thermal strain experienced by the exposed person. Heat index levels rely on two (2) major parameters: **dry bulb temperature and relative humidity**. The following conditions relate to the use of heat index levels given particular values of dry bulb temperature and relative humidity:

- If Heat Stress Index (HSI) is 54 and above, all non-critical jobs shall be stopped.
- Critical jobs is to be performed under strict supervision and with written permission of the Site Manager.
- A **Black Flag** can be used to indicate 'Stop the Job'. A detailed description of the Flagging System is described in Appendix 6.

Heat Stress Index is simply calculated by measuring Relative Humidity and Ambient Temperature (Dry Bulb / Ambient). These two (2) parameters are already measured by the TWL Monitor. The only additional step is to look at the HSI Chart below and find out the value.

HOW TO CALCULATE HEAT INDEX										
		RELATIVE HUMIDITY (Rh)								
		10%	20%	30%	40%	50%	60%	70%	80%	90%
AIR (Ambient/Dry Bulb) TEMPERATURE (C)	50	44	52	54	>54	>54	>54	>54	>54	>54
	49	43	51	54	>54	>54	>54	>54	>54	>54
	48	43	50	53	54	>54	>54	>54	>54	>54
	47	42	48	52	54	>54	>54	>54	>54	>54
	46	41	47	50	54	>54	>54	>54	>54	>54
	45	41	46	50	54	>54	>54	>54	>54	>54
	44	40	45	49	54	>54	>54	>54	>54	>54
	43	39	44	48	54	>54	>54	>54	>54	>54
	42	38	43	46	54	>54	>54	>54	>54	>54
	41	38	41	45	52	54	>54	>54	>54	>54
	40	37	40	43	49	54	>54	>54	>54	>54
	39	36	38	42	47	52	54	>54	>54	>54
	38	35	37	41	43	49	54	>54	>54	>54
	37	34	36	38	41	43	54	54	>54	>54
	36	33	35	37	40	42	49	53	54	>54
	35	32	34	36	39	42	46	52	54	>54
	34	32	34	35	38	41	44	50	53	54
	33	31	32	33	36	38	41	46	50	53
	32	29	31	32	33	36	38	41	46	50
	31	28	30	31	32	34	35	38	41	46
	30	27	29	29	31	32	33	36	38	43
	29	26	27	28	29	30	32	33	35	37
	28	25	26	27	27	29	30	32	33	35
	27	24	25	26	26	27	28	29	30	32
	26	22	24	25	26	26	27	27	28	29

HEAT STRESS INDEX COLOR LEGEND		
DANGER CATEGORY	HEAT INDEX	HEAT SYMPTOMS
	≥ 54	Heat stroke or sunstroke imminent
	39 - 53	Heat cramps or exhaustion likely. Heat stroke possible with prolonged exposure and physical activity
	33 - 38	Heat cramps or exhaustion possible.
	27 - 32	Fatigue possible with prolonged exposure and physical activity

4.4.3.1 MIDDAY BREAK RULE

NOTE: ADNOC Group and Contractors are to also implement the mandatory Local requirements for a midday break for people working under the sun during the summer months (i.e., **UAE Ministerial Decree** No. 401 of **2015 Concerning the Determination of Midday Working Hours**) . As part of this Midday Break Rule, workers are banned from working under the sun or in exposed outdoor areas between 12:30 and 3:00 pm. The employer shall provide an appropriate shelter for workers to rest in during this period.

As per **UAE Administrative Decision No. (19) of 2023 Article (**11), Employers are required to provide shaded areas for their workers to rest during rest periods. For technical reasons, the following works are **exempt and must continue uninterrupted:**

1. Concrete pouring and asphalt mixing that cannot be completed in the afternoon.
2. Repairs and maintenance necessary to avert dangers, damages, malfunctions or accidental losses including:
   a) Cutting off the water supply.
   b) Cutting off sewer lines.
   c) Disconnection of electrical power
   d) Blocking or obstructing major roads
   e) Cutting off gas or petroleum pipelines
3. Projects that require permission from the competent authorities due to their impact on traffic and services. This is if the permit requires work 24 hours a day.

When technical reasons dictate the continuation of work, employers must provide workers with the following additional controls:

1. Provide the worksite with enough cold drinking water to accommodate the number of workers.
2. Hydration fluids, such as lemon juice and minerals, approved by the country's health authorities.
3. On-site first aid materials
4. A sufficient supply of air conditioning
5. Canopies and sunshades.

NOTE: The Group Company shall have the authority/make an informed judgment to decide whether to continue or stop a work activity based on a pre-defined exemption criteria that needs to be proven:

a) if work activity is considered to be business critical;
b) If work activity cannot be postponed outside the Midday Break Hours due to its criticality and emergency nature;
c) if the work activity is included in the exempted list mentioned in Article (11) of the abovementioned UAE Federal Law.

If such a work activity falls in the list above, each GC shall:

1. Identify well in advance the list of work activities mentioned in items (a) and (b) above;
2. Initiate the appropriate Exemption Request, substantiated with risk assessment and appropriate mitigation/precautionary measures (i.e., additional controls) to minimize worker's exposure to high heat stress levels;
3. Maintain a list of contractor groups and employees who shall be working in such activities during the Midday Break period.

Job roles and responsibilities with regard to filing an exemption to the Midday Break Rule for safety critical and essential work are summarized in the Table below.

JOB POSITION	ROLES & RESPONSIBILITIES
Contractor	• Send the Exemption request to site HSE for permission to continue with critical/essential work task/activity
Site/ Project HSE team	▪ Prepares the exemption request and submit to Corporate HSE for review and endorsement ▪ Ensures implementation of precautionary measures as per Beat the Heat proactive action plan.

JOB POSITION	ROLES & RESPONSIBILITIES
ADNOC GC HSE Division	▪ Review and endorse the submitted exemption request (including the review of time and period of exemption) ▪ Maintains register of exemption requests for GC for recordkeeping purposes
Site/Projects VP or SVP (Management)	▪ Approves and implements the exemption request after endorsement of the ADNOC GC HSE Division for the critical/essential work task/activity.
GHSE EOH Division	▪ Compiles Registers of Midday Break Exemption Requests from GCs in log for record keeping, if requested from GC.

Approval of a certain work activity whether to continue or cease shall be based on prescribed conditions and requirements set by the Permit to Work (Work Management System) Corporate Practice HSE-PSW-CP02.

4.4.4. CONTROL OF RISKS

It is required to implement thermal stress control measures according to established risks hierarchy of controls and also in alignment with local and federal regulations. The risk of heat-related illnesses can be reduced by considering and applying one or more of the following established control strategies:

i. Engineering controls that provide a cooler working environment; and / or
ii. Administrative safe working practices aimed at reducing exposure.
iii. Ample awareness, training and information to enable workers to recognize hazardous conditions, potential symptoms and apply the controls that have been provided to them.

a) Engineering Controls

These are the most effective means of reducing excessive heat exposure [Ref. 32], and the examples listed below illustrate some engineering approaches that can be investigated and implemented for reducing exposure to thermal environments:

i. Reducing Metabolic Heat Production (i.e. heat produced by the body): by automation and mechanization of tasks to minimize the need for heavy physical work and the resulting build-up of body heat.
ii. Reducing Radiant Heat Emissions from Hot Surfaces: by covering hot surfaces with sheets of low emissivity material such as aluminium or paint that reduces the amount of heat radiated from the hot surface into the workplace.
iii. Insulating Hot Surfaces: through insulation to reduce heat exchange between the source of heat and the work environment.
iv. Shielding: this is to block radiated heat from reaching workstations. The types of shields that can be used include stainless steel, aluminium or other bright metal surfaces which reflect heat back to the source. Absorbent shields, such as water-cooled jackets made of black-surfaced aluminium, also can effectively absorb and carry away heat.
v. Ventilation and Air Conditioning: by the use of dilution ventilation or localized air conditioning in Operator Shelter or Control Room. These allow workers to cool down after periods of intense heat exposure.
vi. Reducing the Humidity: by application of air conditioning, dehumidification and elimination of open hot water baths, drains, and leaky steam valves help reduce humidity.

b) Administrative Controls

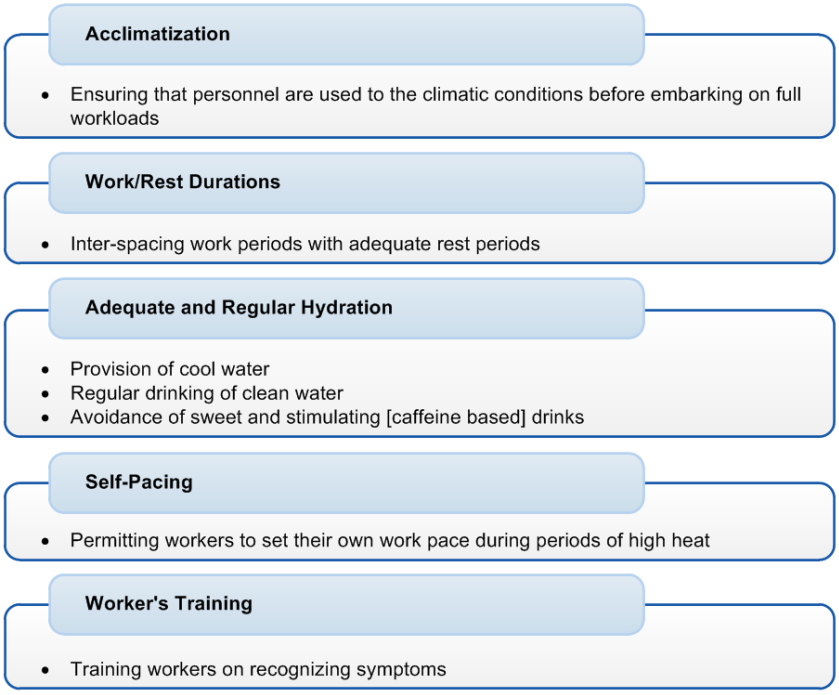

Acclimatization
Ensuring that personnel are used to the climatic conditions before embarking on full workloads
Work/Rest Durations
Inter-spacing work periods with adequate rest periods
Adequate and Regular Hydration
Provision of cool water
Regular drinking of clean water
Avoidance of sweet and stimulating [caffeine based] drinks
Self-Pacing
Permitting workers to set their own work pace during periods of high heat
Worker's Training
Training workers on recognizing symptoms

Figure 4.4.4 (i): Administrative Controls

The following hierarchy of Administrative Controls shall be followed:

1. Work-Rest Regimen

To assist with implementation of the administrative controls relating to rest / work regimens, hydration and other interventions, the TWL index sets out the following guidelines in Table 4.4.4.1.

Table 4.4.4.1.: TWL Working Zones and Interventions for Management of Work [Ref. 57]

Risk Category, Measured TWL (W/m^2)	Recommended Interventions	Work/Rest Schedule (Minutes)	Re-hydration Schedule (litres per hour)
Low Risk, Unrestricted Zone [TWL = 140- 220]	No limit on self-paced work	Safe for all continuous self-paced work	Light work (0.6 – 1)
Medium Risk, Cautionary Zone [TWL = 115-140]	This indicates situations where environmental conditions require additional controls and precautions such as: ○ Implementation of engineering controls [e.g. provision of shaded areas, improved ventilation and other measures stated in	**Light Work** Safe for all continuous self-paced work	**Light work** (1 – 1.2)
		Heavy Work Continuous paced work [45 minutes	**Heavy work** (> 1.2)

Risk Category, Measured TWL (W/m^2)	Recommended Interventions	Work/Rest Schedule (Minutes)	Re-hydration Schedule (litres per hour)
	Section 3.3.1 ○ Working alone to be avoided if possible. ○ Un-acclimatized workers not to work in this zone. Ensuring adequate fluid intake as appropriate for the type of work and environmental conditions	work & 15 minutes rest]	
High Risk, [TWL = <115]	**Strict work-rest schedules** ○ Strict work-rest cycles ○ No person to work alone ○ No un acclimatized person to work ○ High risk awareness, emphasizing hydration and identifying signs of heat strain Provide personal water bottle [2 litres] on site at all times	**Light Work** 45 minutes work & 15 minutes Rest **Heavy Work** (20 minutes work & 40 minutes Rest)	**All Work** (> 1.2)
Notes	Self-paced workers (educated, hydrated workers) are those who are allowed to adjust their work rate according to environmental conditions		
	Paced work is when the work rate is not under the control of the worker		
	Un-acclimatized workers are defined as new workers or those who have been off work for more than 14 days due to illness or leave (outside the tropics and sub-tropics)		
	Light work = sitting or standing, light arm work; Heavy work = carrying, climbing, lifting, pushing, or whole body work.		
	Heavy Work' and 'All Work' categories: "At high workloads and/or thermal stress, sweat rates exceed 1.2 litres/hour. Increasing fluid intake above this rate is not practical due to gastric discomfort as the upper limit for gastric emptying and fluid absorption is ~ 1.5 litres/hour. Control measures to improve thermal conditions shall be implemented in addition to providing adequate hydration to replace sweat lost."		

2. Adjusting Work Schedules

When environmental heat exposure possess a significant risk, such as when the Thermal Work Limit (TWL) falls into the red zone (below 115 W/m²), or the Heat Index exceeds 54—it is strongly recommended **to adjust work schedules by shifting outdoor operations to cooler hours such as late afternoon and evening hours.**

During such extreme thermal conditions, even healthy, acclimatized workers face a high risk of heat strain. By rescheduling work to cooler periods later in the day, organizations can effectively reduce exposure to peak heat stress levels, thereby lowering the likelihood of heat-related illnesses such as heat exhaustion and heat stroke. This proactive scheduling strategy minimizes physiological stress, supports worker well-being and productivity, and aligns with recognized best practices in occupational heat stress management, promoting safer and more sustainable operations during periods of intense environmental heat.

3. Acclimatization

This is the body's mechanism of coping with a new thermal environment. Complete heat acclimatization generally takes about 7 days, but some people may require a slightly longer period [Ref. 32]. Loss of acclimatization occurs gradually when a person is moved permanently away from a hot environment, but a decrease in heat tolerance occurs even after a long weekend. As a result of reduced heat tolerance, it is not advisable for anyone to work under very hot conditions on the first day back to a working week.

New employees are required to acclimatize before assuming a full workload. For experienced employees, it is advisable to assign about half of the normal workload on the first day of work and gradually increase the work period on subsequent days. Well-trained, physically fit workers can tolerate heat better than people in poor physical conditions. However, fitness and training do not substitute the acclimatization regime.

Some medications can interfere with acclimatization. For example, blood pressure tablets, diuretics, antispasmodics, sedatives, and tranquilizers decrease the body's ability to cope with heat. Workers should always seek advice from the medical practitioner on the suitability of a medication for them if they work in hot environments.

Table 4.4.4.2: Guidelines for Acclimatization as a Percent of Effort (as per National Safety Council)

DAY	ACTIVITY (PERCENT OF FULL WORK ASSIGNMENT)	
	EXPERIENCED	NEW
1st	50%	20%
2nd	60%	40%
3rd	80%	60%
4th	100%	80%
5th	-	100%

Re-Acclimatization Guidelines					
Days Away from Heat-Related Job Routine		Exposure Sequence (percent of full work assignment)			
Absence	Illness	1st	2nd	3rd	4th
< 4	–	100%			
4 - 5	1 - 3	R/E*	100%		
6 - 12	4 - 5	80%	100%		
12 - 20	6 - 8	60%	80%	100%	
> 20	> 8	50%	60%	80%	100%

*R/E – Reduced expectations

Table 4.4.4.3: Guidelines for Reacclimatization as a Percent of Effort (as per National Safety Council)

4. Dehydration / Heat Stress Illness Protocol

   The on-site protocol and preparation for emergencies involving heat related illness and dehydration cases shall be planned before heat exposure occurs and be part of the heat stress management process and understood by all personnel Below is a protocol adapted from ADOSH-SF Technical Guideline Safety in the Heat Version 4.0 July 2024 that can be used onsite to plan what should be done to manage cases if they occur at the worksite. This can be modified for a particular worksite accordingly.

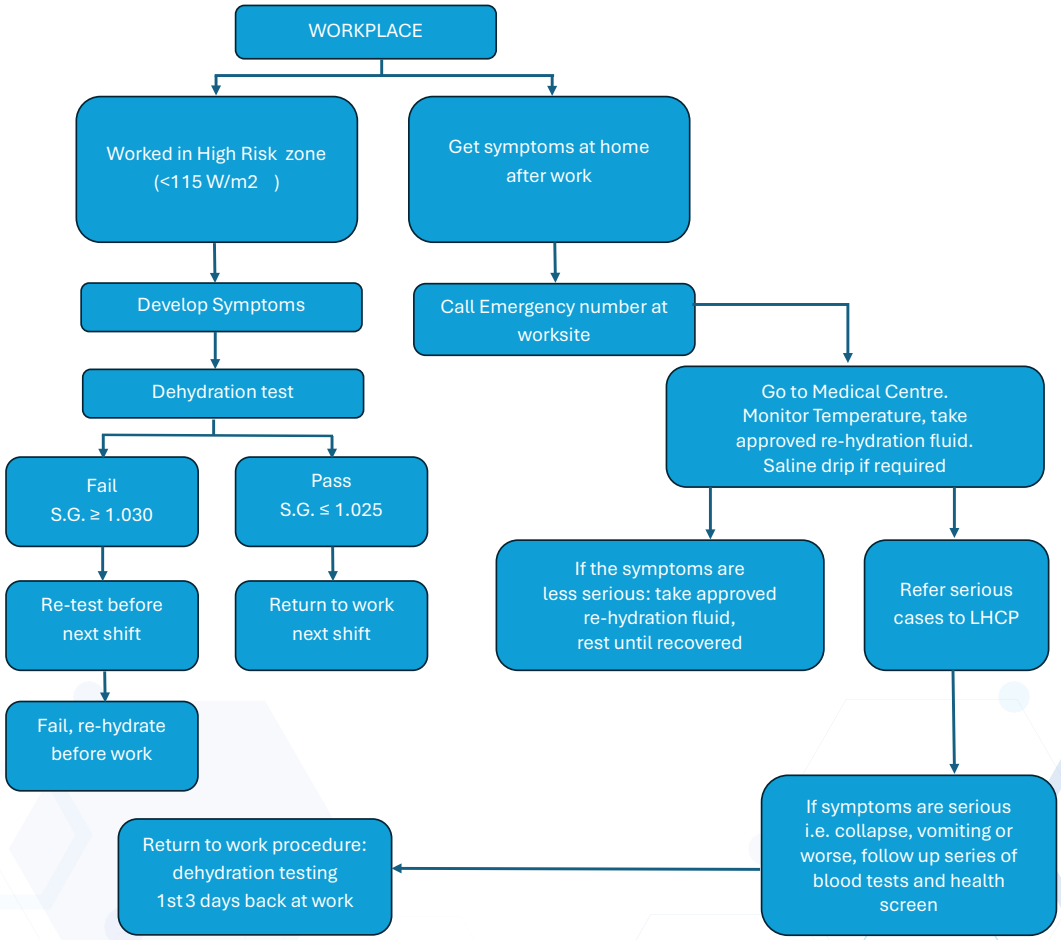
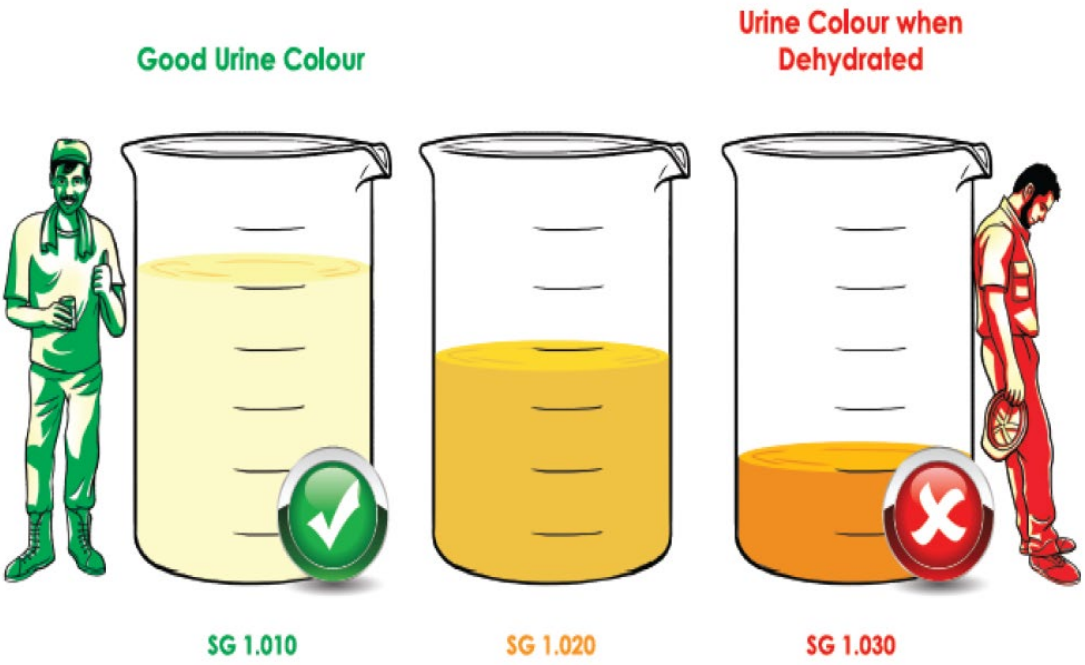

WORKPLACE
Worked in High Risk zone (<115 W/m2)
Get symptoms at home after work
Develop Symptoms
Call Emergency number at worksite
Dehydration test
Go to Medical Centre. Monitor Temperature, take approved re-hydration fluid. Saline drip if required
Fail S.G. ≥ 1.030
Pass S.G. ≤ 1.025
If the symptoms are less serious: take approved re-hydration fluid, rest until recovered
Refer serious cases to LHCP
Re-test before next shift
Return to work next shift
Fail, re-hydrate before work
If symptoms are serious i.e. collapse, vomiting or worse, follow up series of blood tests and health screen
Return to work procedure: dehydration testing 1st 3 days back at work

Figure 4.4.4 (ii) Dehydration and Heat Illness Protocol

5. Urine Colour Charts

Effective hydration is reflected in the colour of the urine or its specific gravity. All ADNOC Group and Contractors shall use Urine Colour Charts (Refer 4.4.3) for monitoring the effectiveness of hydration programs, and as educational tools to encourage workers to drink fluids during the working day in order to avoid heat-related illness.



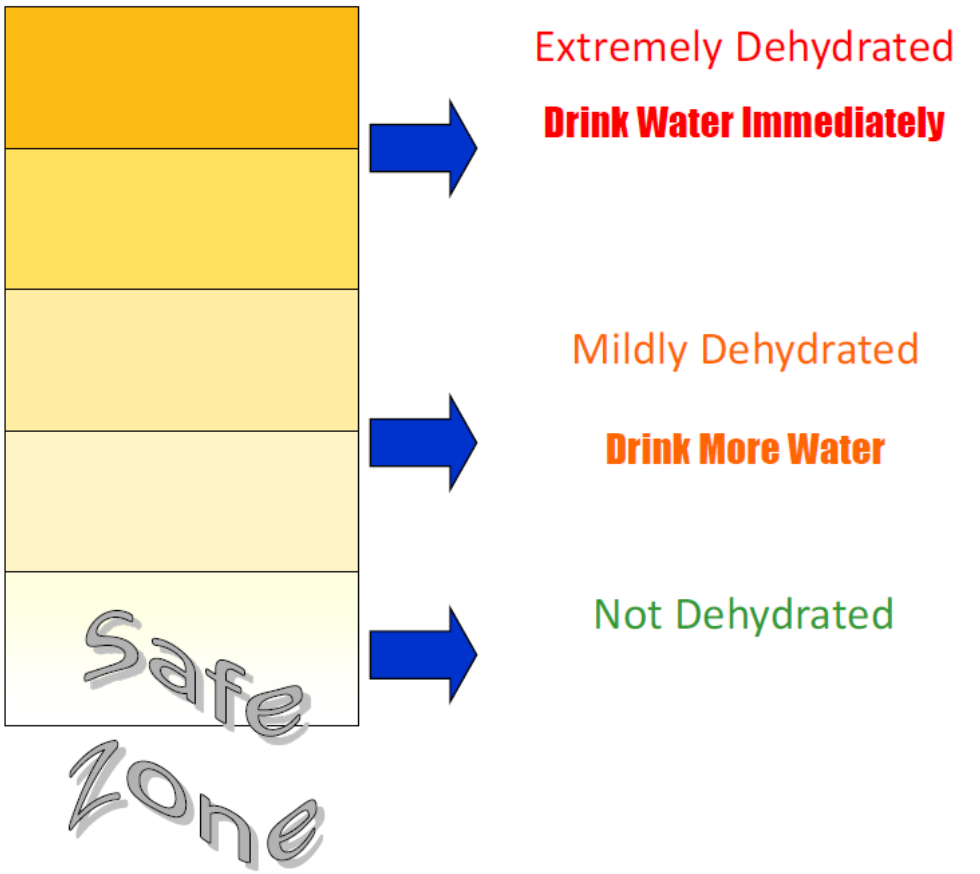


Figure 4.4.4 (iii): Urine Colour Chart

4.4.5. MONITORING OF PERSONNEL

Monitoring of personnel is essential to ensure timely identification of potential heat stress cases. All supervisors / managers are required to visually monitor employees to identify any signs of heat stress. Employees are to be instructed to observe for symptoms of heat stress and be trained on methods to control it. The ADNOC heat stress site assessment checklist shall be used for monitoring as provided in 0.

Any pregnant employee shall not be allowed to work in temperatures higher than 32°C, medical advice should be obtained from the respective medical practitioner the pregnant employee [Ref. 56 & 57].

Affected employees shall be treated by first aider/Emergency Medical Technician (EMT) and medical provider by ADNOC, so in all cases, medical assistance shall be summoned immediately.

To treat heat stress / cramps, remove the victim from the hot environment to a cool area / ambulance or vehicle ideally with 25°C temperature, and loosen tight clothing. Rest the cramping muscles by having the victim sit or lie down. Replace fluids by mouth using water or approved rehydration fluids. Do not give salt or high sodium solutions.

4.4.6. INFORMATION, INSTRUCTION AND TRAINING

Ensure personnel exposed to thermal environments receive appropriate information, instruction and training in thermal environment risks and understand how to use control measures.

4.4.7. HEALTH SURVEILLANCE

Ensure appropriate health screening / surveillance is conducted to identify people at risk (i.e., vulnerable) personnel to heat stress or heat-related illness. A Heat Stress Related Health Surveillance Questionnaire can be found in the ADNOC Health Screening and Surveillance Corporate Practice HSE-OH-CP07; and shall be incorporated as a part of risk assessment and prevention prior to the conduct of a heat stress awareness campaign (e.g., Beat the Heat). The questionnaire should be reviewed and endorsed by the relevant Licensed Healthcare Provider and managed accordingly.

4.4.8. COMPLIANCE ASSURANCE

Assurance and compliance auditing of thermal stress management is to be considered and implemented.

4.5. COLD STRESS

The most significant effect of exposure to cold climate is manual dexterity, especially with prolonged contact with surfaces having temperatures below 15°C. Cold exposure also affects visual acuity as a result of ocular discomfort, including tearing and sensations of dryness accompanies by frequent blinking. The general psychological responses to prolonged work in the cold can be significant. Elements of isolation and confinement due to cold work locations, as well as discomfort from the cold, have been noted to result in behavioural responses. These include changes in arousal, perception, mood, personality and apathy.

One factor that can control exposure from cold stress is cold acclimatization. This lowers the deep body temperature and an increase blood flow through the exposed extremities. These changes help conserve heat by reducing the heat loss gradient. Other controls from exposure to cold stress can include:

i. Provide proper clothing. Choose fabrics that inherently trap air (e.g., wool) and stop air penetration. (e.g., windbreakers);
ii. Allow for self-limiting of work exposure to cold conditions;
iii. Reduce air velocity and minimize drafts (e.g., windbreakers);
iv. Balance work so that periods of intense work are not followed by low work rates;
v. Increase the clothing insulation;
vi. Use windproof clothing as insulation;
vii. Provide hand warming for fine work below 16°C;
viii. Increase radiant heat with micro or spot heaters;
ix. Provide for the use of buddy system;
x. Allow for productivity reductions due to the use of personal protective equipment;
xi. Schedule work/recovery cycles;
xii. Use active warming systems (microenvironmental heating);
xiii. Provide hydration with warm, sweet, non-caffeinated drinks; and
xiv. Encourage a balanced diet.

4.6. RADIATION PROTECTION

Radioactivity is the spontaneous emission of charged particles or photons from an atomic nucleus when in an unstable condition. The process is called nuclear transformation or disintegration or decay that results in loss of mass or charge depending upon the type of charged particles or photons emitted.

Radioactive substances are in common use in the oil and gas industry. Although there are known hazards associated with Radiation, with proper controls risk to health or the environment can be minimized. It is necessary for describing the origins of radiation, the types and properties of emitted radiation and the mechanism by which radiant energy is deposited in various media. It is a standard practice to optimize protection as ALARA (As Low as Reasonably Achievable). The types of radiation are:

i. Non-Ionizing Radiation;
ii. Ionizing Radiation;
iii. Naturally Occurring Radioactive Material (NORM

4.6.1. RADIATION MANAGEMENT

Radiation management activities shall be performed in a standardized and coordinated manner and shall be prioritized based on the level of risk to a person's health. Management of radiation shall be achieved through the following, at a minimum:

i. Compliance with International and Federal Legislation, including compliance with this CP and FANR requirements;
ii. Identification and preparation of inventory of radioactive sources at each facility i.e. Radioactive Sources / Equipment Register as provided in 0.

iii. Characterization of radiation exposures that are likely to contribute to exceedances of occupational exposure limits as per this CP;
iv. Establishment of baseline levels of radiation at each facility including NORM;
v. If presence of NORM has been established, NORM management guidelines for handling, storage, transportation, disposal including NORM-contaminated equipment or waste shall be established;
vi. Assessment, demarcation and monitoring of site-specific Controlled Areas and Supervised Areas; and
vii. Establishing and implementing radiation control strategies to reduce exposure to radiation sources in the work environment.
viii. Time, Distance, and Shielding - Minimizing exposure time, maximizing distance from the radiation source, shielding employee from the radiation source.

4.6.2. NON-IONIZING RADIATION

Non-Ionizing radiation (NIR) is a generic term used to describe part of the electromagnetic spectrum covering two main regions, namely optical radiation (i.e. ultraviolet, visible and infrared) and electromagnetic fields (i.e. power frequencies, microwaves and radio frequencies) as outlined in the sub-sections below.

a) Optical Radiation

This covers visible Infrared (IR) and Ultraviolet (UV) types. The term also covers lasers, but in any case, these emit UV or IR radiation.

The main sources of IR and UV are natural sunlight, but artificial sources include not limited to hot surfaces, arc welding, plasma cutting flames, halogen lamps / sodium light and blowtorches.

It is important to recognise that there are several optical radiation sources in a typical workplace that do not pose any risks to health, hence not necessitating a detailed risk assessment. Listed below are sources that are likely to produce insignificant exposures to optical radiation and hence pose minimal risks, provided, that they are used correctly.

i. Ceiling mounted fluorescent lighting with diffusers over the lamps;
ii. Computer or similar display screen equipment;
iii. Ceiling mounted compact fluorescent/halogen / tungsten lighting;
iv. UVA insect traps;
v. Photocopiers;
vi. Indicator LEDs;
vii. Flame / Flare Scanners – used for flaring.

4.6.2.1 EFFECTS ON HUMAN HEALTH

Optical radiation is absorbed in the outer layer of the body and its biological effects are mostly confined to the skin and eyes, although systemic effects may also occur. Different wavelengths cause different biological effects depending on which part of the skin or eye absorbs the radiation, and the type of interaction involved. For example:

i. Photochemical effects dominate in the ultraviolet region;
ii. Thermal effects dominate in the infrared region; and
iii. Laser radiation can produce additional effects characterized by very rapid absorption of energy by tissue and is a particular hazard for the eyes where the lens can focus the beam.

The Biological effects of exposure to optical radiation can broadly be divided into acute (i.e., rapidly occurring) and chronic (i.e., occurring after prolonged and repeated exposures over a long period). Generally, acute effects will only occur if exposure exceeds certain thresholds [i.e., exposure limits] and the risk of adverse health effect will increase as exposure levels increase above the threshold limit. The majority of effects tabulated below (Table 4.6.1.) will occur in the healthy adult working population at levels substantially above the exposure limits; however, persons who are abnormally photosensitive may suffer adverse effects below the exposure levels.
Chronic effects often do not have a threshold below which they will not occur. Consequently, the risk of these effects occurring cannot be reduced to zero; but the risk can be reduced by limiting exposure to acceptable levels.

Table 4.6.1: Health Effects on Target Organs [Ref. 34]

RADIATION TYPE	WAVELENGTH RANGE, NM	HEALTH EFFECTS ON TARGET ORGAN	
		EYES	SKIN
UVA, UVB, UVC	180-400	Photokeratitis; Photo conjunctivi cataract	Erythema; Elastosis; Sk cancer
UV-B	280-315	Photokeratitis; Photo conjunctivi Cataract	Erythema; Elastosis (photoaging); Skin cancer
UV-A	315-400	Photokeratitis; Photo conjunctivi cataract;	Erythema; Elastosis (photoaging); Immediate Pigment Darkening; Skin cance
Visible	380-780	Photo retinal damage; Retinal bu	Burns
IR-A	780-1400	Cataracts; Retinal burns	Burns
IR-B	1400-3000	Cataracts; Corneal burns	Burns
IR-C	3000-106	Corneal burns	Burns

4.6.2.2. COMPETENCE

Suitably qualified and competent personnel should be assigned to manage the non-ionizing radiation program.

4.6.2.3. NON-IONIZING RADIATION RISK ASSESSMENT

A Qualitative and / or quantitative non-ionizing radiation risk assessment shall be completed. Non-ionizing radiation hazards that have the potential to adversely harm workers shall be identified so that exposure risks can be assessed, and control strategies can be determined and implemented.

Hazard identification activities can be performed by physically walking though the workplace and identifying radiation sources such as density meters, lasers, and magnetic and electrical fields. Qualitative assessment information is to be obtained through interviews with employees and Contractors and through review of applicable records where available, such as equipment registers.

Risk assessment and exposure monitoring is to be aligned with the local regulatory requirements and best international practices. Non-ionizing radiation monitoring shall be conducted where there is a potential health risk or as mandated by regulatory requirements

At minimum, it is required that ,sources emitting the following non-ionizing radiation is identified and included in the radiation risk assessment:

- Ultraviolet Radiation (UV-A, UV-B and UV-C);
- Visible Radiation;
- Lasers; and
- Non-Ionising Electromagnetic Radiation (e.g., static magnetic fields, radiofrequency and microwave radiation)

Ensure that controls, as established by adopting the risk hierarchy of controls, are considered, implemented and are deemed acceptable. Follow up assessment / reassessment should be conducted to determine the effectiveness of controls and recommend additional controls if required.

4.6.2.3.1 ELECTROMAGNETIC FIELDS

An electromagnetic field is a force field generated around an electric current and is equivalent to an electric field and a magnetic field at right angles to each other. Common sources of electromagnetic fields include power lines, household electrical wiring, motor driven instruments, computer screens, telecommunications and broadcasting facilities, and mobile telephones.

In contrast to electric fields, a magnetic field is only produced when a device is switched on and current flows. Thus, the higher the current, the greater the strength of the magnetic field.

Electric fields are strongest close to a charge or charged conductor, but their strength rapidly diminishes with distance. Metal conductors provide an effective shield; and other materials such as bricks, walls, and trees, all provide shielding capability. When power lines are buried underground, electric fields at the surface are hardly detectable.

The strength of a magnetic field is measured in amperes per meter (A/m); or as a flux density (in microtesla, μT).

Low-frequency electric fields influence the human body just as they influence any other material made up of charged particles. When electric fields act on conductive materials, they influence the distribution of electric charges at their surface. They cause current to flow through the body to the ground.

Low-frequency magnetic fields induce circulating currents within the human body and the strength of these currents depends on the intensity of the outside magnetic field. If sufficiently large, these currents could cause stimulation of nerves and muscles or affect other biological processes.

Both electric and magnetic fields induce voltages and currents in the body but even directly beneath a high voltage transmission line, the induced currents are very small compared to thresholds for producing shock and other electrical effects.

Heating is the main biological effect of the electromagnetic fields of radiofrequency fields. The levels of radiofrequency fields to which people are normally exposed are very much lower than those needed to produce significant heating.

4.6.2.3.2 METHODOLOGY FOR MEASURING NON-IONIZING RADIATION [REF. 46]

Measuring non-ionizing radiation depends on the following cases:

- Case 1 Quick Overview: This method shall be applied when just the summation of non-ionising radiation level is required
- Case 2 Variable Frequency Band Scan: This method shall be applied when non-ionising radiation levels are required by frequency within the scanned band.
- Case 3 Detailed Investigation: This method shall be applied where Case 1 and 2 are not applicable.

Location of Measurement Points

Measurement point(s) shall be chosen to represent the highest levels of exposure to which a person might be subjected, considering the positions of neighbouring antennas. These locations can either be found by a quick check using measuring equipment (see case 1 and case 2), or, if that doesn't succeed, by calculation based on the theoretical propagation from neighbouring antennas.

Number of point(s): The measurement shall be made for a single point, 1.5 m above ground (or floor) level.

In case 1 and 3, if the measurement result reaches the decision level, a spatial average of 3 points to match the dimensions of the human body shall be performed.

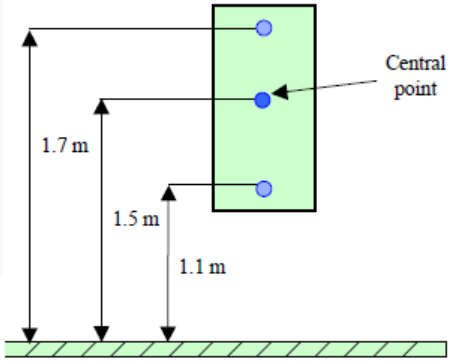


Figure 4.6.1: Non-Ionizing Radiation Field Measurement Points

Measurement Procedure [Ref. 46]
The procedure shall follow these steps:

i. Choose the most suitable probe(s) for the frequency emissions to be studied:

ii. Probes shall be selected to cover the emissions of interest, in certain cases two or more probes would be required to survey the band of interest. In this case, the final result will be calculated using the values given by each equipment (processed as if individually obtained) by using the following **formula:**

$$E = \sqrt{\sum_{i=1}^{n} E_i^2} \quad \text{or} \quad H = \sqrt{\sum_{i=1}^{n} H_i^2}$$

Where;
n is the number of probes covering the frequency band in study; and
Ei or Hi are the value obtained individually by each equipment.

Actual Measurement

The choice of measurement point (location and number of points) will be in accordance with the general

considerations.

The RF radiation sensors shall be mounted on a non-conductive tripod, in order not to perturb electromagnetic field, and will derive the effective, or Root-Mean-Square (RMS) value of E (or H). Personnel shall be retreated from the antenna during measurements.

Measuring Electromagnetic Low Frequency (ELF) [Ref. 48]

- Refer to the survey meter manufacturer's instructions for assembly and operation of the instrument. Note that the meter is factory-calibrated and must be returned to the manufacturer or the equivalent for periodic adjustments and recalibration.
- Measure the dimensions of the area.
- Turn "ON" and zero the ELF electromagnetic fields survey meter.
- Assure that the computer and VDT (and other peripherals such as printer) are turned "OFF."
- Using the tape measure, record levels of ELF electromagnetic fields at various distances from the computer and VDT screen, specifically including distances of 5 cm, 25 cm, 50 cm, and 1 m and heights of 50 cm, 1 m, 1.5 m, and 2 m.
- Turn "ON" the computer and VDT and repeat measurements.
- Complete a field monitoring data form, remembering to record your name, facility and location sampled, date, and EMF meter manufacturer and model.

4.6.2.3.3 NON-IONIZING RADIATION EXPOSURE LIMITS

There are no UAE regulatory Occupational Exposure Limits for optical radiation, however ADNOC has adopted the latest ACGIH TLV and BEI booklet on the appropriate Threshold Limit Values for:

- TLVs for Sub radiofrequency (30 kHz and below) Magnetic Fields
- Radiofrequency and Microwave TLVs
- Ultraviolet Radiation TLV and Relative Spectral Effectiveness
- Ultraviolet Radiation TLV and Relative Spectral Effectiveness (for the Skin)
- TLVs for Direct Ocular Exposures (Intrabeam Point Source Viewing from a Laser Beam)
- TLVs for Extended Source Laser Viewing Conditions
- TLVs for Skin Exposure from a Laser Beam

4.6.3. NON-IONIZING RADIATION EXPOSURE CONTROLS

Non-ionizing radiation exposure controls (following the hierarchy of control) shall be implemented.

Follow up assessment/ reassessment shall be conducted to determine the effectiveness of controls and additional controls can be recommended as appropriate.

4.6.4. INFORMATION, INSTRUCTION AND TRAINING

Entities are to ensure that respective personnel receive appropriate information, instruction and training in non-ionizing radiation risks as well as how to implement the required control measures.

4.6.5. HEALTH SURVEILLANCE

It is required to ensure that health surveillance is conducted for personnel exposed to significant levels of non-ionizing radiation.

4.6.6. COMPLIANCE / ASSURANCE

Assurance and compliance auditing of non-ionizing radiation management is to be considered and implemented.

4.6.7. IONIZING RADIATION

Ionizing radiation activities are regulated by the Federal Authority for Nuclear Regulation (FANR) in UAE and it is the responsibility of ADNOC Group and Contractors to comply with its applicable regulations. However, the following shall provide a framework for Ionizing Radiation Management.

Ionizing radiation occurs either as electromagnetic rays (e.g. X-rays and gamma γ-rays) or as particles (e.g. α and β particles), but it also occurs naturally from the radioactive decay of natural substances such as radon gas.

4.6.7.1 INDUSTRIAL RADIOGRAPHY

Industrial radiography is a method of inspecting materials for seeing hidden flaws by using the ability of X-rays, gamma rays and neutrons to penetrate various materials. It is a major element of non-destructive testing.

Industrial radiography for non-destructive testing is used to inspect, among others, concrete and a wide variety of welds, such as those in gas and water pipelines, storage tanks and structural elements. It can identify cracks or flaws that may not be otherwise visible. These characteristics have made non-destructive testing a key tool for quality control, safety and reliability. Industrial radiography uses two types of radiation; namely x-rays and gamma (γ) rays.

A Radiography Safety Plan shall be developed by the third-party service provider before the commencement of any radiography-related activity. The GC RPO/RSO/RPA shall review and approve the aforementioned Plan. A sample of Radiography Safety Plan is found in the Appendix.

4.6.7.2 X-RAYS AND GAMMA-RAYS

X-rays used in Non-Destructive Testing (NDT are produced by a large generator which is used in a fixed location and is similar to medical x-ray machines, radiation is present only when these machines are turned on. Portable industrial radiography units are smaller in size as compared to X-ray machines and use negligible amount of radioactive gamma-emitting material in a sealed source, which is typically less than 1 cm in diameter and a few centimetres long. Portable industrial radiography units are heavy in weight due to the shielding which is added to protect operators from ionizing radiation.

X-ray machines are also used for medical imaging during examination for orthopaedic damage, lung disease, tumours or foreign objects in the human body, or for assessing tooth decay or damage.

Table 4.6.2: Characteristics of Alpha, Beta and Gamma Radiation

RADIATION	DESCRIPTION AND EFFECTS
Alpha (α)	α particles are helium nuclei that are heavy and positively charged. This causes them to lose their energy very quickly in matter and thus can be easily stopped from further travel. They can be stopped by a sheet of paper or the surface layer of the human skin. α particles are hazardous to health only if inhaled or ingested.
Beta (β)	β Particles are much smaller compared to α particles and only have one (negative) charge which causes them to interact more slowly with material. They are effectively stopped by thin layers of metal or plastic. Some beta particles are capable of penetrating the skin and causing damage such as skin burns. However, as with alpha-emitters, beta-emitters are most hazardous when they are inhaled or swallowed.
Gamma (γ)	γ Emitters are associated with α and β decay and are a form of high energy electromagnetic radiation that interacts lightly with matter. Gamma rays are best shielded by thick layers of lead or other dense materials and are considered as an external hazard to living tissues (i.e. the human body).

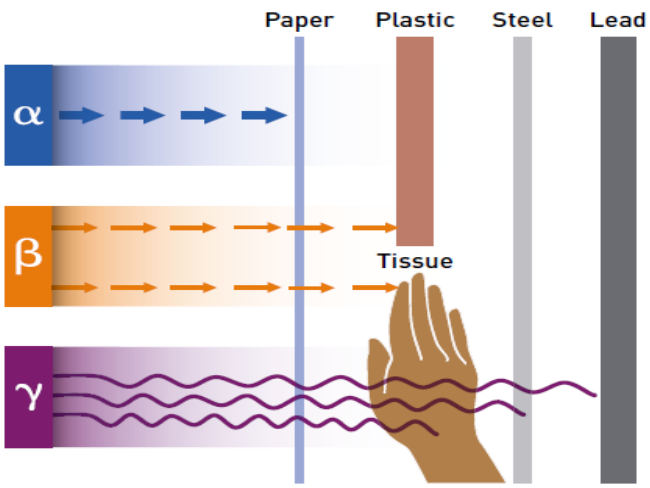


Figure 4.6.2: Penetration Power of Ionizing Radiation [Ref. 45]

4.6.7.3 HEALTH EFFECTS OF IONIZING RADIATION

There are two routes for human exposure to ionising radiation; these are either (a) irradiation from an external source which remains outside the body (e.g. X-ray machines, or during handling and working with radioactive sources); or (b) contamination, where the radioactive material enters the body by inhalation, ingestion or absorption.

Effects of radiation exposure are either somatic (i.e. relating to the body) and / or genetic (relating to the human offspring), as shown below in Table 4.6.3.

Table 4.6.3: Effects of Ionizing Radiation to Health [Ref. 37]

SOMATIC (I.E., BODY)	GENETIC
Acute effects range from erythema [i.e., redness of the skin] to dermatitis. Large whole-body exposures cause nausea, vomiting, diarrhea, weakness and ultimately death	Genetic effects may lead to congenital defects in the employee's offspring.
Chronic effects include skin cancer and suppression of bone marrow functions.	
Other symptoms including leukemia and cancers of the lung, stomach, esophagus, bone, thyroid, the brain, and nervous system.	

Table 4.6.4: Dose-Dependent Acute Health Effects of Ionizing Radiation [Ref. 37]

GROUPING	RANGE OF DOSES (GY)
Hematopoietic From 0.25 Gy: No Clinical symptoms but are slightly increased frequency of chromosomes aberrations may be detected in lymphocytes From 0.25 to 1 Gy: Either no symptoms or transient nausea. Biological test may reveal a lymphopenia accompanied in some cases by slight thrombopenia. Cytogenetic changes in lymphocytes are readily detected. Some studies have shown slight changes in the patient's electroencephalogram.	1-10
Gastrointestinal	10-20
Cardiovascular or Toxaemic	20-50
Nervous System	Above 50

4.6.7.4 COMPETENCE

Suitably qualified and competent personnel shall be assigned to manage the ionizing radiation program. In line with FANR regulations and guidelines, it is a mandatory requirement to have a Licensed / Certified Radiation Protection Officer (RPO) / Radiation Safety Officer (RSO) / Qualified Expert (QE) managing any regulatory material.

4.6.7.5 METHODOLOGY FOR MEASURING IONIZING RADIATION: RISK ASSESSMENT

Qualitative and / or quantitative radiation risk assessment(s) and radiation survey is to be conducted. It is to be ensured that the results of the risk assessment are recorded and that actions required by identified and implemented as deemed necessary.

Radiation monitoring is to be carried out where there is a potential risk to health or as required by Regulatory requirements. It is required that risk assessment and exposure monitoring is undertaken in line with the local regulatory requirement and best international practices.

4.6.7.5.1 SCREENING OF IONIZING RADIATION

Radiation Screening is divided into the following categories:

1. Area Exposure Screening (Surface contamination survey)

It is required that total (fixed plus removable) contamination shall be measured by direct survey with portable radiation survey instruments sensitive to beta / gamma radiation (e.g., pancake Geiger-Mueller detector, or equivalent) or alpha radiation (e.g., alpha scintillation detector), or equivalent).

The instrument shall be turned on and permitted to stabilize for a minimum of 30 seconds) prior to performing surveys.

With the appropriate probe, exposure screening of a radiation-contaminated area is conducted by slowly passing the probe over the area or object to be surveyed. The survey is done at a constant speed - approximately 2 cm/sec. The fixed distance of 1 cm from the surface or object shall be adopted.

2. Personnel Exposure Contamination Screening (Whole Body Contamination Survey)

If feasible, perform a complete, whole body contamination survey and record the findings. To begin a body survey, the individual shall stand with their legs spread and arms extended.

- First holding the probe about a half-inch away from the surface to be surveyed, slowly (1-2 inches per second) move the probe over the head, and proceed to survey the shoulders, arms, and bottoms of the feet. Care must be taken not to permit the detector probe to touch any potentially contaminated surfaces.
- Pause the probe for about five seconds at locations most likely to be contaminated:
    - Top and sides of head, face (pause at mouth and nose for approximately five seconds; high readings may indicate internal contamination);
    - Front of the neck and shoulders;
    - Down one arm (pausing at elbow), turn arm over;
    - Backside of hands, turn over (pause at palms for about five seconds);

- Up the other arm (pausing at elbow), turn arm over;
- Shoe tops and inside ankle area;
- Shoe bottoms (pause at sole and heel).

4.6.7.5.2 EXPOSURE RATE MEASUREMENTS

All employees and Contractors shall be designated as **Occupationally Exposed Workers** if they exceed integrated dose rate exposures of 1 mSv/year (i.e., effective annual dose limit for the general public). These occupationally exposed workers will be required to participate in a site-specific personal monitoring program in accordance with this Corporate Practice.

It is important that monitoring shall be an element of the site-specific radiation dose assessment program and be performed through the use of personal radiation dosimeters and thermoluminescent dosimeter badges/Instadose, which shall be supplied by an ADNOC Group-Approved Third-Party Contractor to perform the following service activities:

1. External: Whole Body - assess doses received by Occupationally Exposed Workers, including the measurement and assessment of whole-body doses arising from external radiation (notably X-rays, gamma rays, beta particles or neutrons);
2. External: Whole Body - Special Accident - assessing and reporting doses rapidly following an accident, occurrence or incident when requested to do so by the employer; and
3. External: Extremity / Skin Routine - assess doses received by Occupationally Exposed Workers, including the measurement and assessment of part-body (e.g. skin, eyes) doses arising from external radiation (notably X-rays, gamma rays, beta particles or neutrons).

All Occupationally Exposed Workers will be required to wear personal radiation dosimeters whilst they are engaged in work with radiation. Dosimetry results shall be reviewed and compared to the dose limits, and an annual report on the cumulative and effective doses received by each Occupationally Exposed Worker shall be prepared by the site RPO.

4.6.7.5.3 PRE OPERATIONAL CHECKS

- Pre-operational checks shall be completed at the start and end of each day the instrument is used.
- Each instrument shall be labelled with a unique identifier (e.g., serial number of detector and rate meter) to enable traceability to surveys and records.
- Prior to each use, or at the start and end of each day the instrument is used, each instrument shall be checked for the following: battery function, operating voltage, reset button function, audible response function, physical damage,
- Verify that the instrument was calibrated within 12 months prior to its use.
- Test the instrument response to a reference radioactive source.
- If any response is different from the mean measurement by more than 3 standard deviations (±3δ), that instrument shall be removed from service.
- If any two consecutive daily responses exceed the mean measurement + the 2 δ value, the instrument may be removed from service pending an evaluation of its operational status.
- Document the instrument response to background radiation.

- Response to background radiation shall be determined at the start and end of each day the instrument is used, at a reproducible location in the vicinity of the measurement site but not near known radiation sources.
- Three readings shall be obtained at the start of each work shift, and three readings are to be obtained at the end of each work shift.
- The results of the daily checks is to be recorded on a record sheet.
- Instruments failing any pre-operational check is to be taken out of service, segregated from other instruments, tagged as “out of service”, and repaired prior to use.

4.6.7.6 RADIOACTIVE LEAK TESTING

In line with FANR regulations and guidelines, a leak test in terms of surface contamination reactivity (i.e., either in Becquerels, counts per minute, counts per second) shall be performed for any regulatory source to ensure safety and protection of workers. **Leak test frequency shall be performed at regular intervals as per manufacturer’s recommendations or FANR requirements.** In case of any abnormalities in leak detection, further investigation shall be performed to control any unnecessary radioactive emissions from the source / equipment.

4.6.7.6 FANR REGULATIONS AND RELEVANT PROVISIONS

The following are the few examples of FANR Regulations and requirements that is to be followed by FANR Licensee within ADNOC Group. The list found in Table 4.6.5 is not an exhaustive list. For latest version of applicable FANR regulations, FANR Licensee in ADNOC Group shall contact FANR to understand compliance requirements.

In case of lack of policy/guidance on a radiation-related exposures, references from the following organizations can be consulted, which include but not limited to: International Atomic Energy Agency (IAEA); International Committee on Radiological Protection (ICRP); and International Radiation Protection Association (IRPA).

Table 4.6.5: Regulations by FANR

REGULATION NUMBER	RELEVANT PROVISIONS AND DOSE CONSTRAINTS
FANR RG 006	If you carry packages under exclusive use, the radiation level at any point on the outer surfaces of the vehicle may not exceed 2 mSv/h.
FANR-RG-007	The Occupational Dose Constraint mSv/year for the following to be: ▪ Industrial Radiography – 6 mSv/year ▪ Diagnostic Radiology, Fixed Gauges, Portable Gauges, X-Ray Scanners, Well Logging – 3 mSv/year **NOTE:** The Authority also recommends individual monitoring for any **Worker who is likely to receive more than 10% of the annual Dose limit of 20 mSv in any one year.** For most cases individual monitoring means that Workers must wear personal dosimeters. Article (11) details the provisions of a **Radiation Safety Assessment**. Article (18) and (19) establish procedures for reporting and learning from **Accidents and Incidents**. Article (26) recommends specific engineering, administrative controls and personal protective equipment to mitigate exposure from ionizing radiation.
FANR-RG-18	Specific Guidance for Management of Residues in Industrial Processing: • Clearance if Exposure from the Radioactive Material in all reasonably foreseeable situations delivers an annual effective Dose to an individual member of the public in the order of 10 µSv or less, and that for low probability scenarios the Effective Dose does not exceed 1 mSv in a year. • Article (7) details provisions on **Storage of Radioactive Waste**, including primary and secondary containment of liquid waste, tank design, adequate ventilation, and early leak detection system.
FANR REG 19	• Where Activity Concentrations above the Reference Level are identified, the Existing Exposure Responsible Entity, in consultation with the Au thority, shall establish a protection strategy comprising coordinated actions with the aim of ensuring that the Effective Dose to the Representative Person does not exceed 1 mSv per annum and that Protection is optimised. • Articles (6), (7), (8), (9), and (10) contains detailed provisions on requirements for personnel exposed to areas contaminated with residual radioactive material.
FANR RG 19	• Any Doses received by a short-term worker within the past five years and make sure that his or her total Dose does not exceed the worker Dose limits of an average of 20 mSv per year averaged over a period of five years and 50 mSv in any one year • The Authority recommends that industrial radiography Licensees use a worker Dose constraint of 6 mSv per year and considers that a Dose Constraint for Public Exposure below 0.1 mSv per year is generally acceptable • Article (3) and Annex 1 contains detailed provisions on the conduct of **Radiation Safety Assessment**
FANR-REG-23	• Article (4) and Schedule B details provisions on **radiation security plans**, including transport security plans

REGULATION NUMBER	RELEVANT PROVISIONS AND DOSE CONSTRAINTS
	• **Radiation source access control** is detailed in Article (6) and Article (8)
FANR-REG-24	Licensee shall ensure that the normal exposure of workers does not exceed the Dose limits as per the following: ▪ Effective dose to an Occupationally Exposed Worker receiving Occupational Exposure is an **average of 20 mSv per year averaged over a period of five years (100 mSv in 5 years)** and 50 mSv in any one year; ▪ Annual equivalent dose in the **lens of the eye** of a worker shall not exceed **shall not exceed 150 mSv,** nor shall the annual Equivalent Dose **exceed 500 mSv** at any point on the **hands, feet or skin**; • **Pregnant workers** (if applicable in ADNOC Group) receiving occupational exposure during normal operations shall not exceed **1 mSv/year** for the remainder of pregnancy • Article (15) provides details on prevention of **radiation-related accidents** • Article (16) describes in great detail the development of a **Radiation Emergency Plan** • Article (22) explains provisions on **personal protective equipment** needed when handling radioactive sources • Article (27) contains specific provisions on **training** needed for personnel handling radioactive sources and equipment
FANR-REG-29	Article (6) contains provisions on **radiation safety assessment** requirements before license can be granted.

4.6.8 CONTROL OF RISK: IONIZING RADIATION

Once radiation risks have been identified and assessed, the required resources are to be directed to establishing and implementing radiation control strategies. At a minimum, site-specific Radiation Control Plans are to be established based upon FANR requirements and prioritised based upon the class of risk (i.e. High, High-medium, Medium or Low) in combination with the number of persons exposed and the frequency and magnitude of the exposure. The site-specific Radiation Control Plans should aim to control exposures to radiation using one or a combination of the following:

- Reducing radiation exposure time;
- Increasing distance between works and radiation sources; and / or
- Intercepting radiation pathways.

Time

There is a direct relationship between radiation dose and time of exposure. Therefore, Radiation Control Plans are to include documented actions aimed to reduce an individual's radiation dose by controlling the amount of time exposed to radioactive sources and substances.

When exposed to high-risk radiation levels, an individual's dose levels shall be routinely monitored during work using personal dosimeter alarms.

Distance

Increasing the distance between a radiation source and a person will reduce the person's exposure to radiation.

It is required that occupational environment monitoring results shall be utilized to establish and demarcate site-specific Controlled Areas and Supervised Areas.

Physical barriers and warning signs are to be erected to indicate where Controlled Areas and Supervised Areas exist and should allow an appropriate minimum separation distance.

Routine occupational environmental monitoring, where applicable, shall be performed to validate that the physical barriers afford an effective distance to control a person's exposure to radiation.

Shielding

Radioactive sources shall be effectively shielded to ensure the maximum effective dose rate on the surface of the container does not exceed 2 mSv/hr as per FANR-RG-006 Article 4 Section 5. At a minimum, the selection of radiation shielding shall consider the following:

- The type of radiation requiring shielding;
- The desired effect of the shielding;
- The availability of required shielding materials;
- The maintenance and inspection requirements for the shielding; and
- The frequency and extent of use.

The site RPO shall be consulted in all circumstances where shielding is purchased and installed to ensure shielding is adequate as improper shielding can actually increase the amount of harmful radiation.

4.6.9 STORAGE OF RADIOACTIVE MATERIALS

Unless permanently installed as part of a measuring device (process control or density gauges), all sources are to be kept in a locked store kept solely for radioactive materials and their immediate containers and associated items such as handling tools. Appropriate signage is to be displayed external to the store, in order to warn persons in and around the vicinity that the store may contain radioactive materials. The sign will be required to include a trefoil and the word 'Radioactive'.

Figure 4.6.1: Radioactive / Radiation Warning Sign

The maximum dose rate at the outside of the fence of a temporary storage area to which the public has access cannot exceed 1 μSv/h above background.

To ensure the safety and security of the sources, a temporary storage facility will be required to:

i. Provide adequate shielding
ii. Be physically secure (e.g. locked when not in use), and access to key is controlled;
iii. Not be used as a general storage area for other goods
iv. Be fireproof and not contain other hazardous materials (e.g. flammable liquids and explosive materials)
v. Be dry and weatherproof
vi. Be appropriately labelled (e.g. radiation trefoil and warning notices with the legend "RADIOACTIVE").
vii. Be monitored through a **surveillance camera.**

More details on the security requirements when storing radioactive sources or equipment can be found in FANR REG 23: Regulation for Security of Radioactive Sources.

When nucleonic devices are placed into temporary storage, daily checks are to be carried out by site RPO; and the Radioactive Register to reflect the change of location.

4.6.10 SOURCE DISPOSAL

Ensure that radiation waste and sources are disposed of appropriately to prevent any exposure to people.

As soon as a nucleonic device becomes redundant, i.e. when there is no foreseeable use for the device, arrangements shall be made for its disposal. The exhausted radioactive source / device shall be returned to the Supplier / Third Party Contractor for handling and safe disposal. The entire nucleonic device shall be removed as per ADNOC Waste Management Corporate Practice HSE-ESP-CP04 [Ref. 52].

It shall be ensured that the Supplier/Third Party Contractor all relevant permits to carry out the work and any other permissions and export licences required to dispose of the source(s). It shall be ensured that the Supplier/Third Party Contractor has made arrangements for onward shipping, and where necessary, temporary storage of radioactive sources.

On completion of the work, the **Radioactive Material/Equipment** Register shall be updated to reflect the change in the source inventory.

4.6.11 EMERGENCY PLANS

It is a requirement of both FANR-REG-24 Article (16) and the site license that contingency / emergency plans are available for work with Ionizing Radiation. Contingency plans are to be periodically reviewed for its effectiveness. For the introduction of a new source/renewal of existing Ionizing Radiation source, a Contingency Plan shall be developed. Qualified Expert shall be responsible in the development of a radiological emergency plan, with the Radiation Protection Officer responsible for carrying out or directly supervising contingency plans in the event of an Accident or Incident (as per FANR RG-007, RG-019).

More details can be found in the ADNOC Crisis Management and Emergency Response Practice HSE-EC-CP01

4.6.12 MANAGEMENT OF CONTRACTORS WORKING WITH IONISING RADIATIONS

The use of radiation and radioactive materials by contractor's in either a sealed or unsealed form, may be carried out periodically on ADNOC Group managed sites, both offshore and onshore.

Contractors are exposed to ionising radiations through the following sources:

i. Industrial radiography using sealed sources or X-ray machines.
ii. Well logging using gamma and neutron sealed sources (either wire-line operations or measuring while drilling techniques) and magnetron neutron generators.
iii. Vessel, pipe or jacket member scanning using sealed sources.
iv. Radiotracer work involving the injection of unsealed radioactive material into vessel or pipeline.

4.6.13 INFORMATION, INSTRUCTION AND TRAINING

All personnel exposed to radiation receive appropriate information, instruction and training in radiation risks and how to implement control measures. Training and awareness shall be provided in line with FANR regulations and guidelines to workers who are likely to be exposed to regulatory sources.

4.6.14 HEALTH SURVEILLANCE

All Occupationally Exposed Workers to ionizing radiation shall be certified "fit for work" prior to engagement in radiological work. For SEGs exposed to radiation hazards, health surveillance examination will be as per ADNOC Group Medical Fitness Guidelines 2022 [Ref. 57]. A Radiation Health Surveillance Questionnaire can also be found in the ADNOC Health Screening and Surveillance Corporate Practice HSE-OH-CP07.

4.6.15 REPORTING FOR RADIOACTIVE SOURCES

Various types of reports dealing with radioactive sources can be found in FANR-REG-24, Article 19 [Ref. 8].

4.6.16 COMPLIANCE AND ASSURANCE

Assurance and compliance auditing of ionizing radiation management is to be considered and implemented. On an annual basis, an internal audit plan shall be developed to ensure compliance with the national and international regulatory bodies.

4.7. NATURALLY OCCURRING RADIOACTIVE MATERIALS - NORM

NORM includes radioactive elements found in the environment. Long-lived radioactive elements of interest include uranium, thorium and potassium, and any of their radioactive decay products, such as radium and radon. These elements have always been present in the earth's crust.

These are also known as Low Specific Activity (LSA) materials and are associated with oil and gas exploration, development and production activities because these species are mixed in with the water, oil and gas that are present in reservoir formations. Due to the acidity of reservoir water, elements such as uranium, thorium and their daughter isotopes Radium-226 and Radium-228, present in the rock minerals are leached into the water.

During processing of oil & gas within a well, NORM are brought to the surface by the formation pressure or as a result of injection of seawater. Generally, levels of NORM in water, oil and gas are very low. However, as changes in pressure and temperature occur, and when mixed with injected seawater, Radium 226 & 228 may co-precipitate with barium sulphate and natural carbonates to form scale. The scale deposits in pipelines and surface equipment and sludge containing Radium 226 & 228 may also accumulate in pits and tanks.

Radium-226, which is the most common isotope found in NORM, is an alpha emitter and accompanied by gamma radiation. The isotope has a half-life of ca. 1600 years. The second isotope Radium-228 is a beta emitter and has a half-life of 5.76 years.

4.7.1. NORM IN OIL AND GAS PRODUCTION

Analysis of oil and gas from many different wells has shown that the long-lived uranium and thorium isotopes are not mobilized from the rock formations that contain them. However, Ra-226, Ra-224, Ra-228 and Pb-210 are mobilized, and appear mainly in the water co-produced during oil and gas extraction. These isotopes and their radioactive progeny can then precipitate out of solution, along with sulphate and carbonate deposits as scale or sludge in pipes and related equipment. Radon-222 is the immediate decay product of Radium-226 and preferentially follows gas lines. It decays (through several rapid steps) to Pb-210 which can therefore build up as a thin film in gas extraction equipment.

The level of reported radioactivity varies significantly, depending on the radioactivity of the reservoir rock and the salinity of the water co-produced from the well. The higher the salinity, the more NORM is likely to be mobilized. Since salinity often increases with the age of a well, old wells tend to exhibit higher NORM levels than younger ones.

a) Mineral Sand

Mineral sands used generally as abrasive blasting material (e.g., sand and garnet) may contain zircon, ilmenite, and rutile, with xenotime and monazite. These minerals are mined in many countries and production amounts to millions of tonnes per year of zirconium and titanium (from rutile and ilmenite), though thorium, tin and the rare earth elements are associated. The NORM aspect is due to monazite – a rare earth phosphate containing a variety of rare earth minerals (particularly cerium and lanthanum) and 5-12% (typically about 7%) thorium, and xenotime – yttrium phosphate with traces of uranium and thorium.

The minerals in the sands are subject to gravity concentration, and some concentrates are significantly radioactive, up to 4000 Bq/kg. Most of this NORM ends up in the waste streams from mineral processing (often including monazite) and so, apart from zircon, the final product is itself devoid of NORM. However, sometimes niobium and tantalum are recovered from the waste stream, and residues may be used as either landfill or in construction sites where there is a possibility of public exposure.

Table 4.7.1: Radioactivity in Mineral Sands and Products [Ref 38]

NORM MATERIAL/SUBSTANCE	THORIUM		URANIUM	
	PPM	BQ/KG	PPM	BQ/KG
Ore	5-70	40-600	3-10	70-250
Heavy mineral concentrate	80-800	600-6600	<10-70	<250-1700
Ilmenite	50-500	400-4100	<10-30	<250-750
Rutile	<50-350	<400-2900	<10-20	<250-500
Zircon	150-300	1200-2500	150-300	3700-7400
Monazite concentrate	10,000-55,000	80,000-450,000	500-2500	12,000-60,000250-25,000
Processing tailings (including monazite)	200-6000	1500-50,000	10-1000	

b) NORM in Scale

Scale formation by barium and strontium sulphate and / or calcium carbonate is well known in oil and gas facilities. Radium behaves chemically the same as Barium (Ba), Strontium (Sr) and Calcium (Ca). Hence radium co-precipitates with Sr, Ba or Ca scale forming radium sulphate, radium carbonate and in some cases radium silicate. Typical build-up of scale on the interior of a pipe is shown in Figure 4.7.1.

Radioactive molecules containing radium which are not incorporated into scale may be found in sludge, produced sands, and produced water. Other radionuclides such as Lead-210 and Polonium-210 can be deposited as a thin layer inside pipe work, transfer pipelines and associated equipment and as sludge accumulating in tank bottoms, gas / oil separators, dehydration vessels, natural gas liquid storage tanks and waste pits.

Figure 4.7.1: NORM in Sludge and Scrapings

4.7.2 EXPOSURE TO NORM

4.7.2.1 NORM SCREENING THRESHOLDS

Exposure may occur by skin contact as a result of unprotected handling of NORM-containing plant or equipment; or else by inhalation if the materials are dislodged by mechanical forces, e.g. wire brushing or pipe rattling. Specifically, personnel working on cutting and reaming oilfield pipe, or removing solids from tanks and pits, and refurbishing or processing equipment may come into contact with NORM).

i. Any source of NORM which has concentration below 1 Bq/g is exempted being classified as NORM. [Ref. 42]
ii. Consequently, a substance or material exceeding a concentration of 1 Bq/g and possesses a member of the 232Th- or 238U-decay series, may be defined as NORM. [Ref. 42]
iii. Soil shall not have a Ra-226 contamination above 0.185 Bq per gram (5 pCi per gram)
iv. Production waters with concentrations below 10 Bq/L (i.e. 228Ra, 226Ra and/or 210Pb) may be treated as exempt. [Ref. 42]
v. The IAEA stipulate a reference level of 1000 Bq/Nm3 [air] (i.e. 222Rn) for potential exposure to radon in the workplace. [Ref. 42]

Figure 4.7.2 provides guidance on how to classify potentially contaminated materials (e.g., tubulars) as NORM or not. Basically, there are two (2) primary criteria that need to be satisfied for an equipment to be classified as suspected NORM:

- Surface equipment readings obtained are greater than 5 CPS OR double the background, AND
- Gamma dose rate is greater than 0.5 microsieverts per hour at 0.5 m from its surface.

In case the potentially contaminated equipment gives surface readings greater than 5 CPS or double the background, but gamma dose rate is LESS than 0.5 microsieverts per hour, at least 20% of the potentially contaminated equipment shall be screened for NORM. If any of the equipment screened gives off a gamma dose rate of 0.5 microsieverts per hour or higher, then that equipment shall be considered as suspected NORM and radiometric/gamma spectrometric analysis of the sample from the equipment shall be performed.

If the sample gives off a radionuclide activity of 1 Becquerel per gram or higher; then the entire batch of the equipment shall be declared as NORM-contaminated, and appropriate NORM management strategy shall be followed (see section 4.7.3).

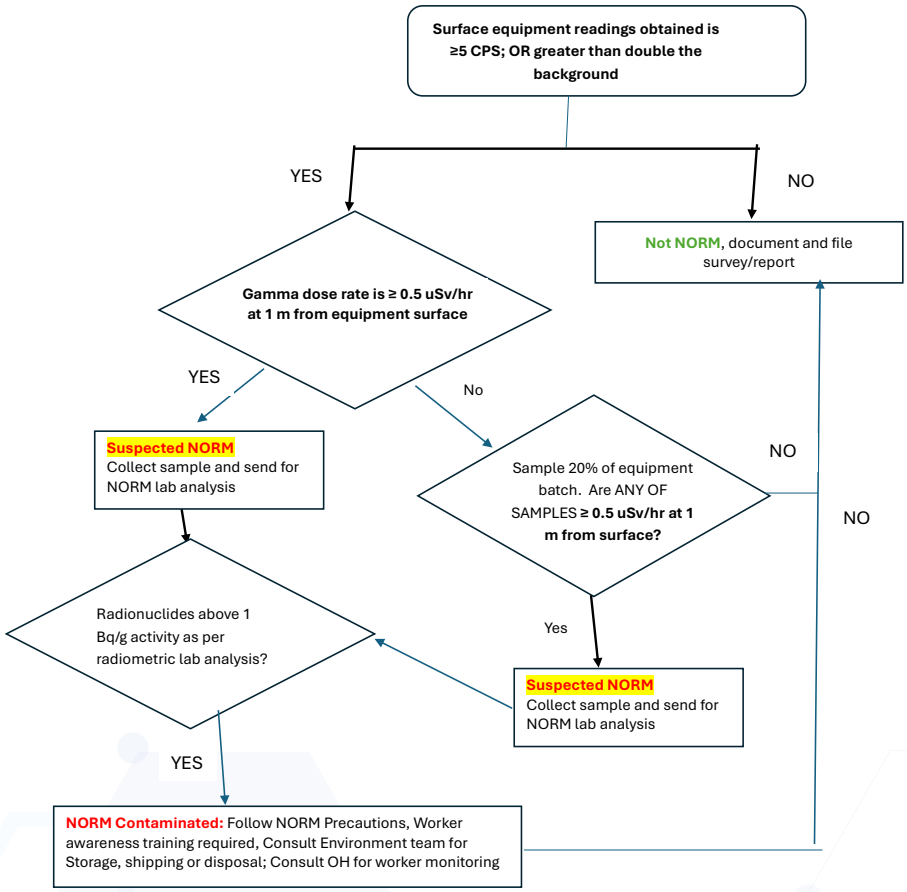

Surface equipment readings obtained is ≥5 CPS; OR greater than double the background
YES
NO
Not NORM, document and file survey/report
Gamma dose rate is ≥ 0.5 uSv/hr at 1 m from equipment surface
YES
No
Suspected NORM
Collect sample and send for NORM lab analysis
Sample 20% of equipment batch. Are ANY OF SAMPLES ≥ 0.5 uSv/hr at 1 m from surface?
NO
NO
Radionuclides above 1 Bq/g activity as per radiometric lab analysis?
Yes
Suspected NORM
Collect sample and send for NORM lab analysis
YES
NORM Contaminated: Follow NORM Precautions, Worker awareness training required, Consult Environment team for Storage, shipping or disposal; Consult OH for worker monitoring

Figure 4.7.2: NORM Screening Strategy

4.7.2.2 WORKER EFFECTIVE DOSE LIMITS FOR NORM

The normal duties of workers do not include exposure to NORM radiation. However, they shall follow as per FANR-REG-24 regulations where any employee exposed to above 1 mSv/year shall be considered as Occupationally Exposed Worker, while any employee exposed to less than 1 mSv/year shall not be considered as Occupationally Exposed (i.e., members of the public).

Occupationally Exposed Workers

As per FANR-REG 24, Effective dose to an Occupationally Exposed Worker is an average of 20 mSv per year averaged over a period of five years (100 mSv in 5 years) and 50 mSv in any one year. Occupationally Exposed workers are also subject to periodic medical surveillance. More details can be found in the ADNOC Health Screening and Surveillance Corporate Practice HSE-OH-CP07.

4.7.2.3 NORM SURVEY

4.7.2.3.1 NORM MEASUREMENT TYPES

NORM measurements are taken to determine the concentration of radioactive materials present in scale, sludge, soil, etc., or to determine the potential for radioactive exposure to people near the material.

Field Measurement

a. Survey Meters: NORM Contamination Meter (Gamma Surface Scans)

   This contamination measurement device shall be used as an indicator for screening against background radiation levels in order to locate and identify any “hotspots” on the item to be checked rather than a quantifiable measurement. It shall be noted that this is only a screening technique and not a method of determining whether waste media, soil, installations are actually NORM-contaminated waste, which can only be determined by laboratory analysis of collected samples.

b. External Dose Rate Meter

   If the readings obtained using contamination meter exceed background level, an external radiation dose measurement is to be carried out using Dose Rate meter at a distance of 1 meter from the active source.

c. Laboratory Measurement

   In order to quantify the actual NORM contamination and determine whether the materials and waste media, soil, equipment, vessels, and clothing are classified to be NORM waste; samples should be collected and sent to accredited laboratory for radiometric analysis. Currently, ADNOC Group relies on third-party laboratories for this analysis. RPO shall advise on sampling & transport requirements as well as relevant accredited laboratories.

4.7.2.3.2 NORM SURVEY TYPES

The following are different types of survey, which are required to be addressed as part of ADNOC Group operations and monitoring program as defined in the following Table 4.7.2.3.2.

Table 4.7.2.3.2: NORM Survey Types

SURVEY TYPES	OBJECTIVES	INSTALLATIONS	REMARKS
Baseline surveys	Establish a baseline survey for the spread and level of NORM accumulation in facilities. This information yields important data about NORM waste streams.	Vessels in gas/oil separation facilities Wellheads	It is recommended that sites with NORM contamination be resurveyed every two years to identify changing conditions. NORM baseline survey results shall be recorded.
Pre-Shutdown surveys (Pre Testing &	Determine the specific locations of NORM	Tanks Separators	Records of Pre T&I and PM NORM surveys shall be maintained by site

SURVEY TYPES	OBJECTIVES	INSTALLATIONS	REMARKS
Inspection and Preventive Maintenance Survey)	accumulation in facilities where NORM contamination is suspected prior to a shutdown.		RPO.
Operational Assessment	Enable field operations to identify NORM contamination promptly during routine operational scenarios	Down-hole Tubing, Safety Valves etc. Long piping runs Wellheads Production Manifolds Flowlines (to Gas/Oil Separators) Separators (High, Intermediate, and Low) Dehydrators Desalinators Valves Gas / Oil Separator baffle plates Oil Storage Tank	Follow ADNOC safe systems of work including, but not limited to, PTW and Task-based Risk Assessment (TRA).
Legacy contamination surveys	To identify areas with potential legacy NORM contamination before the implementation of NORM management strategy	Land farms Evaporation ponds Disposal pits Other areas (Equipment storage / maintenance areas) where NORM contamination potentially accumulated	

The following details shall be considered for performing Radiation Surveys for external surface of equipment, waste drums, tubular, tanks, vessels, and other items contaminated with NORM:

i. Carry out initial survey beyond the site boundary to measure background radiation levels in cps using contamination meter.
ii. Hold the probe close to the surface to be surveyed, moving slowly over the area, noting any response from the contamination meter and compare to background levels.
iii. If measured radiation levels from the contamination meter are found twice the background levels, measure dose rate in µSv/h, at a distance of 1 meter from the contaminated equipment using the dose rate meter.
iv. Measure NORM at different positions of the potential NORM-contaminated equipment (i.e. “12 o’clock”, “4 o’clock’ & “8 o’clock” positions) at three different heights & average of the three readings at each height to be summarized.
v. When surveying tubulars, the insides of the pipe shall always be checked by placing the probe a few centimetres inside each end and record the results.

4.7.2.3.3 NORM CONTAMINATION MONITORING - WIPE TESTS

Monitoring for the presence of alpha/eta contamination on a surface is usually carried out by direct measurement with contamination probe. This direct measurement reading simply indicates whether Alpha / Beta contamination on a surface is present. However, additional information by carrying out a 'wipe test' is to be obtained. A wipe test allows a distinction to be made between fixed and loose contamination.

i. Wipe a tissue over the surface to be surveyed with an area of 300 cm2; this will remove a proportion of the contamination.
ii. Take the wipe to a low background area and if the tissue is wet allow drying.
iii. Hold the wipe as close as possible to the contamination probe (Alpha and Beta Probe) without touching it and note any response from the meter. Record the results.
iv. The Correction factor for wipe test is 2 for an area about 300 cm2.

a) Radiation Survey of Personnel for Contamination

i. Hold the alpha and beta probe with the window as close as possible to the surface of the body (within 1 centimetre) without touching it. Slowly pass the probe over the area, noting any response from the rate meter at a rate of 5 to 7 cm per second.
ii. Certain areas of the body require special attention, including:
    1. The head and hair.
    2. The face, especially around the mouth and nostrils, paying special attention to any facial hair.
    3. Hands and feet, including cuffs and ankles of clothing.
    4. Knees, elbows, and forearms.
    5. The buttocks.
iii. Record the results.

4.7.2.3.4 NORM AREA CLASSIFICATION BASED ON SURVEY DOSE RATE LEVELS

- **Exempted Area**

  Exempted area is a location where suspected or unconfirmed NORM-containing material having a gamma radiation dose of < 1 µSv/h is present.

- **Unrestricted Area**

  It is a location where the estimated incremental gamma radiation dose to the public is in the range of 1.0 to < 2.5 µSv/h.

- **NORM Supervised Area**

  It is a location where the external radiation dose limit is between 2.5 to 7.5 µSv/h above background. The area shall be demarcated with tape and radiation warning signs. In a Supervised Area, exposure conditions and time are monitored to allow for reliable prediction of the dose to individual workers.

- **NORM Controlled Area**

  It is a location where the radiation external dose limit is above 7.5 µSv/h above background. Specific protective measures and safety provisions are required as illustrated in Table 4.7.2.3.4.

Table 4.7.2.3.4: NORM Area Classification

µSV/H	DEFINITION	REQUIREMENTS
<1	Exempted Area	• No precautionary action is needed.
1.0 to < 2.5	Unrestricted Area	• Normal Work Permits • Basic Approved PPE • Good Hygiene • Restricted to general public
2.5 to 7.5	NORM Supervised Area	• Work to be supervised by RPO or his delegate at all times • Use NORM applicable PPE • Control public access by RPO or his delegate • Demarcation with warning NORM sign • Train workers • Monitor NORM levels before and after work completion • Inform HSE focal points • Permit To Work (PTW) required
Above 7.5	NORM-Controlled Area	• Stop the work • Implement Dose Management Strategy • Inform line manager and RPO for further instruction • Control worker access by RPO or his delegate • Demarcation with warning NORM sign • If dose rate exceeds 7.5 µSv/hr, workers exposure must be controlled below the annual exposure of dose rate of 20 mSv/year.

4.7.3 NORM STORAGE

Storage of NORM-contaminated equipment shall follow the requirements in Section 4.6.9 (Storage of Radioactive Waste), as well as the legal provisions stated in FANR-RG-18 Predisposal Management of Radioactive Waste, Article (7). In addition, the following are recommended:

i. **Suitable containers**: NORM is temporarily stored in suitable containers where sludge is stored in drums or barrels with lids and clamping rings. For NORM-contaminated pipes/tubulars, valves, and similar are stored in containers with lids, and covered with water to 10 centimetres above the contents in the container.

ii. **Fencing off**: If the dose rate measured immediately on the outside of the waste containers exceeds 7.5 microSv/h, the storage area is secured off with barrier tape and radiation signs are put up.

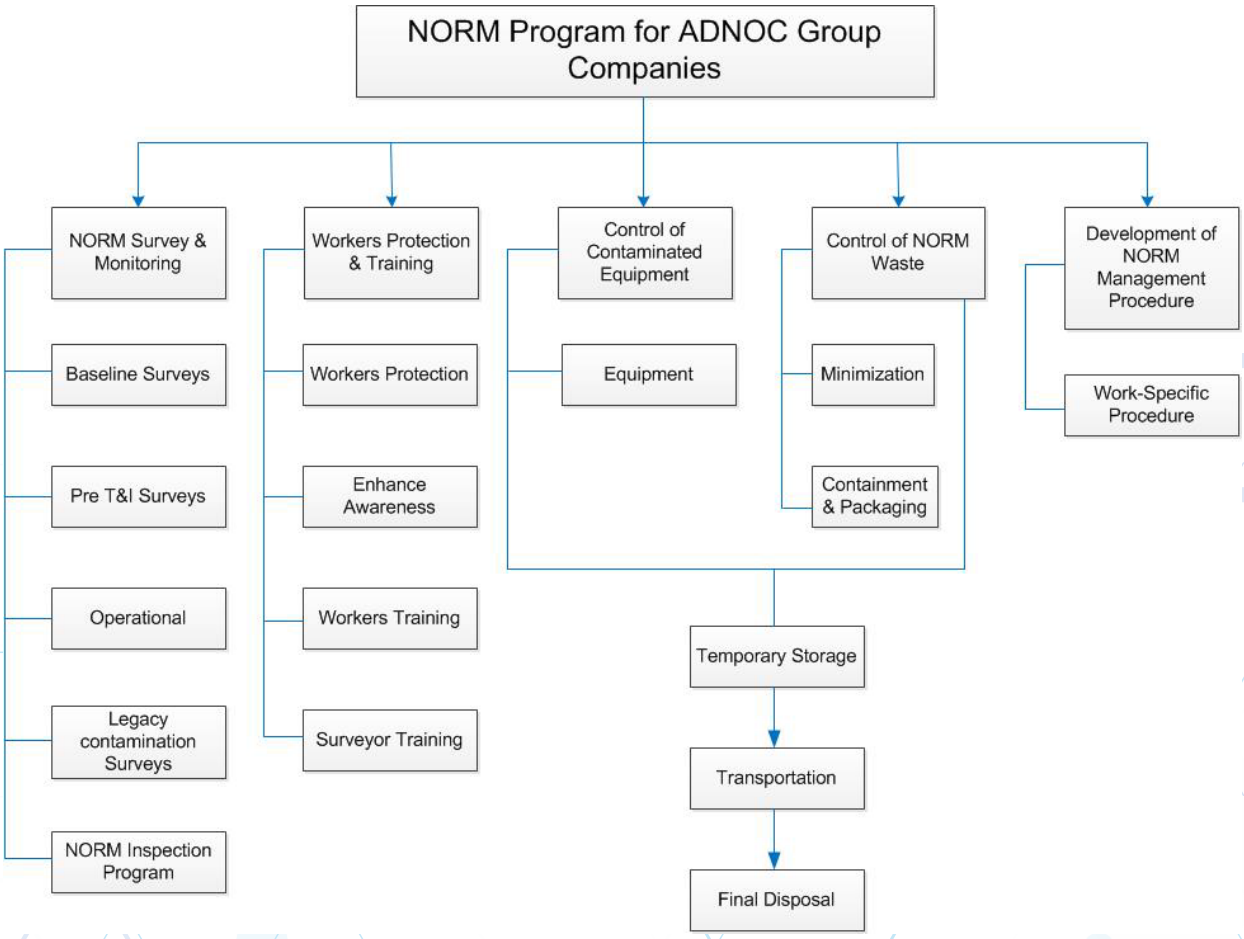
4.7.4 NORM MANAGEMENT STRATEGY

NORM can be intrinsic to oil, gas & waters produced from certain geological formations. Consequently, these can be virtually impossible to eliminate or substitute as part of a viable radiation risk control plan.

To enable the NORM management process cycle to be effective, a strategy has been developed for its implementation (Refer to Figure 4.7.3). The key areas which require to be targeted are:

- NORM Survey and Monitoring (discussed in section 4.7.2.3.2 and 4.7.2.3.3)
- Workers' Protection and Training (discussed in section 4.7.4.2)
- Control of NORM Contaminated Equipment (discussed in section 4.7.4.4)
- Control of NORM Waste (please refer to ADNOC Waste Management Corporate Practice HSE-ESP-CP04);
- Development of NORM Management Procedure (shall be prepared at GC level based on operational requirements)

Figure 4.7.3: NORM Management Program for ADNOC Group



Note: Scale, sludge, equipment contaminated with NORM, miscellaneous waste contaminated with NORM (plastics, wood, oils etc.) can only be disposed of, in an approved NORM disposal facility as per ADNOC Waste Management Corporate Practice HSE-ESP-CP04.

4.7.4.1 NORM INSPECTION PROGRAM

The RPO must conduct NORM inspections and carry out radiation measurements at defined points in the production lines to assure that the levels of radiation received by workers are within the ADNOC acceptable levels specified in Section 4.7.2.2 of this Corporate Practice.

Records

It is required that all data collected during a NORM survey is properly documented and accurate records should be maintained for a minimum period of 40 years. Information and data collected may be subject to review and evaluation many years in the future.

The records that are to be maintained include:

- Field survey forms
- Instrument operational checks
- Instrument maintenance and calibrations
- Sample analytical results
- Thermoluminescent Dosimeter (TLD) analyses. (Personnel radiation exposure may be evaluated either by having personnel wear Thermoluminescent Dosimeter or film badges).

4.7.4.2 WORKERS PROTECTION AND TRAINING

During normal operating conditions at NORM-impacted sites, external radiation exposure is usually low enough that no changes to normal work procedures are required. However, during non-routine operations such as well workovers, equipment maintenance, equipment handling and repair, and vessel entry, employees may have direct physical contact with NORM-impacted sand, scale, and sludge. Site RPO shall evaluate the levels of NORM and determine if employee exposures have the potential to require monitoring.

Personnel working with NORM shall be given awareness and training on the associated health hazards by trained RPO.

External radiation exposure involves external source with gamma radiation of which controls are straight forward and simple as follows:

- Minimize the time spent close to a NORM installation (vessels, pipes, valves, pumps), or the exposure time when the workers are handling NORM wastes during desludging. The total dose a person will receive while near a NORM installation or waste is directly proportional to the length of time for which worker is exposed.
- Maximize the distance between personnel and any NORM installations. Radiation exposure decreases rapidly as one moves further from NORM installations.
- Maximize the shielding (i.e. steel containment) between personnel and norm installations.
- Wear personal monitoring device (dosimetry) if working in controlled areas to measure radiation dose while tracking exposure time.

4.7.4.3 WORKERS PROTECTION FROM INTERNAL RADIATION FOR NORM

Internal radiation exposure involves internal source with Alpha and Beta particles, which enters the body by inhalation, ingestion and surface cuts. Internal radiation requires more stringent precautions than when working only with gamma radiation as follows:

- Employees and contractors shall be advised of the presence and potential risks of NORM as well as the procedures to minimize exposure.
- Personnel radiation exposures at NORM-impacted sites shall be assessed and working area(s) are to be classified as described in Table 4.7.3.
- Appropriate PPE shall be worn which may include but not restricted to the following:
- Disposable one piece waterproof / splash proof coveralls (i.e. Tyvek suit with hood)
- Impervious gloves (Neoprene, polyvinyl chloride or nitrile butyl rubber)
- Rubber or PVC boots
- Eye protection with safety glasses with side shields
- Safety hardhat
- Minimum required Respiratory Protective Equipment (RPE) whose wearer underwent a respirator fit test.
- Follow Personal Hygiene procedures to prevent personal contamination.
- Follow Good Housekeeping procedures to control the spread of contamination or contaminated equipment and waste.
- Keep NORM-contaminated equipment and waste (e.g., scale sludge) wet all the time to minimize dust airborne generation during handling.
- Any opening of NORM-contaminated equipment shall be capped, sealed or wrapped in plastic sheet to minimize the spreading of any dust.
- Eating, drinking and chewing or applying cosmetics (e.g., sunscreen, lipstick) shall not be allowed in the immediate work area where equipment or soil-containing NORM is being handled.
- Only designated personnel shall be allowed in the work areas with potential NORM contamination.
- To prevent ingestion of NORM-impacted material, personnel are required to wash their hands and face before eating, drinking, smoking, chewing, or applying cosmetics after working on equipment containing NORM.

4.7.4.4 BASIC NORM CONTAMINATION CONTROLS

The following list presents the basic control procedure that is to be practiced when handling NORM contaminated waste and installations i.e. equipment, tubulars, vessels, pipes or machinery:

- The boundary of NORM-contaminated area is to be demarcated at a safe distance meeting the background levels.
- Post the boundary with radiation warning signs “Caution: NORM Materials” with radiation trefoil as per Figure 4.7.4 below:

Figure 4.7.4: NORM Warning Sign

- Only those who are operationally required shall be allowed access.
- Proper containers shall be provided for contaminated waste materials including discarded personnel protective equipment
- Impermeable ground cover at work areas shall be provided to prevent ground contamination
- Seal contaminated equipment in suitable plastic material and label them “NORM-contaminated materials”.
- Obsolete NORM-contaminated pipes or equipment shall be clearly identified as “NORM-contaminated materials” and removed to a designated area. The area shall be labelled as “Containing radioactive materials” and restricted for the general public.
- Keep the contaminated wastes wet to prevent them being airborne.
- Collect representative samples of the waste generated.
- Communicate information and provide training on radiation, contamination control, PPE requirements, safe work practice, waste management and emergency response.
- PPE shall be removed before the workers leave the work environment. The used PPE shall be decontaminated or disposed of as NORM waste.
- Survey all equipment before it exit the work area to ensure that they are contamination-free.
- After completion of the work, the area shall be surveyed for contamination.
- Once the survey results do not show any contamination, the boundary markings and sign boards shall be removed

4.7.4.5 NORM DECONTAMINATION

In general, NORM removal at dedicated facilities is more efficient, however for tank and some equipment cleaning, this must be undertaken on site before any type of NORM removal operations begins and certain precautions shall be taken. The following procedures are required to be followed when performing NORM impacted installations cleaning.

These procedures can also serve as a guide for evaluating the resources of third-party contractors performing such work. Contractor HSE shall be consulted to ascertain the eligibility of contractors to perform the required work. Employees involved in NORM removal operations are to be adequately trained. Records of such training are to be maintained.

- Equipment, vessels, and clothing shall be considered NORM contaminated if internal or external surface contamination measures double the radiation background level;
- Permanent cleaning areas shall be paved and curbed with concrete to avoid ground contamination. Plastic ground covers shall be placed in and around a temporary NORM cleaning area before any cleaning operation begins. Plastic ground covers are used to contain contaminants and facilitate clean-up procedures after operations are complete;
- Any type of NORM removal activity shall take place in a well-ventilated area;
- All personnel involved in the removal process shall be familiar with personal protective equipment that shall be worn during removal operations;
- Entry into the cleaning area shall be restricted to authorized personnel, and the number of people within the cleaning area shall be kept to a minimum;
- Workers shall keep all materials that contain NORM in a wet state to prevent the inhalation of dust. Dry removal processes must be designed to prevent dust releases;
- Radiation survey readings shall be taken in and around the cleaning area before the cleaning operations begin. Initial readings shall be compared to readings taken after cleaning operations are complete;
- The removed scale, sludge, and other particles shall be placed in appropriate containers for storage. All NORM-impacted process/wash water shall be contained, re-circulated, or filtered to remove NORM material. The ultimate disposal of wash water after settlement of solids must be injected into field disposal wells along with produced water or transported to drilling mud disposal wells at appropriate locations;
- If the cleaning process does not reduce radiation levels to acceptable levels, the equipment could be stored, reused, or re-cleaned, but it shall not be released for unrestricted use.

4.7.4.5.1 CLEANING METHODS

The choice of the removal procedure shall depend on its removal efficiency as well as the resources, cost, and safety considerations outlined earlier.

a) Manual cleaning

Manual cleaning does not involve any machinery and may be as simple as hand washing equipment with detergent and water. The removal of NORM-impacted tank sludge could be done by manual cleaning (for example, shovelling the sludge from the tank and placing it into storage containers), or washing and pumping could do it.

b) Mechanical cleaning

Mechanical cleaning methods vary widely and may include high-pressure water washing, drilling or reaming, and vacuuming.

c) High-Pressure Water Blasting

Water blasting is a commonly used method of NORM removal. It is used to clean scale from production equipment, such as separators and tanks, as well as from tubing and pipes. High pressure water blasting is usually defined as water jetting operations using pressure above 750 psi. NORM scale cleaning operations typically range in pressure from 10,000 psi to 30,000 psi. High pressure washing systems shall be closed systems. Wash water shall not be allowed to escape to the environment and so it needs to be contained, recirculated, or filtered to remove scale. The ultimate disposal of wash water after settlement of solids must be injected into field disposal wells along with produced water or transported to drilling mud disposal wells at appropriate locations.

d) Drilling or Reaming

Drilling or reaming is typically used in the cleaning of production tubing and piping. A tube will be positioned on a cleaning rack and a reamer enters one end of the tube to begin cleaning. This process has high removal efficiency but may generate NORM impacted dust if used as a dry process. Wet drilling processes may be used to reduce the amount of dust generated. As with high pressure water blasting, wet and dry drilling processes shall be closed systems to prevent the release of NORM materials.

e) Vacuuming

Vacuum systems may be wet or dry processes and are generally effective in removing loose material. Vacuuming is often used before manually cleaning equipment. Vacuum systems shall be properly filtered to prevent the spread of material to surrounding areas and reduce the potential for airborne activity. Care shall be taken to ensure that large amounts of NORM material do not accumulate in the vacuum system.

f) Equipment in Gas Service

NORM material may occur in natural gas processing equipment as thin films, which are often invisible to the naked eye. These films may consist of radioactive materials that embed themselves into the walls of the processing equipment. Chemical film removal or grinding may be necessary to remove NORM film from gas plant equipment. Additionally, NORM material may accumulate as a dusty black powder on the internal surface of gas processing / storage equipment. The powder, often iron sulfide, has been shown to potentially contain elevated levels of Pb-210. It shall be noted that, due to the radioactive species present, radiation conditions may exist when systems are opened for cleaning or refurbishment that may not be readily identified when the systems are closed.

4.7.4.5.2 PERSONNEL DECONTAMINATION

Personnel are required to wash thoroughly with soap and tap water following RPO instructions:

- After working with NORM
- Before eating and drinking or smoking
- End of workday

05. HYPERBARIC PRESSURE

Atmospheric (or barometric) pressure is the pressure exerted by the mass of atmosphere above sea level. This pressure decreases as we move upward through the atmosphere and increases as we descend down into a mineshaft or deep into the sea.

As a rough indicator, the following pressure levels can be experienced:

- 1 atmosphere = 1 bar Boat at Sea level;
- 2 Atmosphere = 2 bar Diver working at 33 feet or 10 meters of sea water;
- 3 atmosphere = 3 bar Diver working at 66 feet or 20 meters of sea water.

5.1. SOURCES

Potential sources of hyperbaric pressure can be found in the following:

- Hyperbaric Oxygen Therapy (HBOT)
- Commercial Divers
- Recreational Scuba Divers
- Submarine operations
- Pressure Testing Engineering
- High Altitude flights

5.2. COMPETENCE

Assign suitably qualified and competent personnel to manage hyperbaric pressure hazards. A competent individual is someone who has a good knowledge of hyperbaric pressure and its health effects, as well as managing risk, a program for risk management, including control measures for mitigation of exposure.

5.3. HEALTH EFFECTS

The main hazards associated with working in hyperbaric pressures, particularly during diving and conducting underwater welding and maintenance mainly relate to safety issues. However, hyperbaric exposure caused by diving is associated with several Occupational Health Hazards such as decompression illness (DCI); gas embolism and barotrauma. Some also relate to exposure to airborne contaminants in the breathing air and noise.

Recovery from hyperbaric conditions depends on the severity and nature of the diving incident, but in many cases, it can be complete with the person making a full recovery. However, there is less certainty about the possible long-term health effects of diving, particularly in the absence of an obvious safety related injury.

Dysbaric osteonecrosis [i.e., death or breakdown of bones caused by reduced blood flow in the bones and joints] has been associated with diving and is now a notifiable industrial disease among divers in UAE. Other aspects of health, however, have raised concerns among divers which include neurological abnormalities, lung function changes and inner ear damage.

5.4. RISK ASSESSMENT

A qualitative and / or quantitative hyperbaric risk assessment to assess risk to personnel. ADNOC Group and its Contractors shall carry out risk assessments where there is the likelihood of an employee being exposed to hyperbaric pressures. The target of the risk assessment shall be to identify what actions shall be taken to ensure that the risks to health are eliminated or minimized.

The framework for carrying out risk assessments is detailed in ADNOC OHRM Corporate Practice HSE-OH-CP01. In that respect, assessments shall be carried out by competent personnel and the information collected during the assessment shall be reliable and reflective of current operations and plant/process conditions.

The assessment shall be recorded and shall contain a plan showing prioritized actions for dealing with the High or High Medium risks, as well as a timed schedule of actions / deliverables and responsibilities for closing out the actions. Risk assessment and exposure monitoring should be undertaken in line with the local regulatory requirement and best international practices.

5.5. CONTROLS

Ensure controls for hyperbaric pressure is following the hierarchy of control and are implemented and acceptable. This requirement is supported by:

- IOGP Guidance: Report 384 ‘Health Risk Assessment and Management

It is required to ensure that controls are considered and implemented by following established risk hierarchy of controls and that these are deemed acceptable. Follow up assessment / reassessment are required to be conducted to determine the effectiveness of hyperbaric pressure controls and recommend additional controls if required.

5.6. INFORMATION, INSTRUCTION AND TRAINING

It is required to ensure personnel receive appropriate information, instruction and training in hyperbaric pressure risks and how to implement control measures.

5.7. HEALTH SURVEILLANCE

Ensure health screening / surveillance is completed for personnel exposed to hyperbaric pressure hazards, as appropriate. A Divers Medical Surveillance Questionnaire is found in the ADNOC Health Screening and Surveillance Corporate Practice HSE-OH-CP07

06. COMPLIANCE ASSURANCE

ADNOC will conduct assurance audit of this Corporate Practice at appropriate intervals based on risk-based audit plans in line with HSE-MS-CP04 HSE Audit & Assurance. ADNOC will take steps to minimize overlap and duplication between ADNOC Corporate and Group Companies internal audits.

The main audit deliverable is a formal and structured report for the attention of GC Management and the respective ADNOC Directorate.

6.1. PERFORMANCE KPIS

Table 6.1.1: Physical Health Hazard KPIs

No.	KPI	Targets
1.	Submission of Health Hazard Risk Register specific to Physical Hazards to ADNOC GHSEF and subsequent resubmission on periodic basis.	100% completion
2.	Performance - Timely action on any identified findings related to Physical hazards identified.	100% completion
3.	Periodic submission of Radioactive Source Inventory Register to reflect any changes (i.e., newly purchased radioactive source/equipment, decommissioned/disposed radioactive source/equipment)	100% completion
4.	Periodic submission of radioactive leak test and survey dose rate tests as required	100% completion

07. GLOSSARY

TERMS	DEFINITIONS/ABBREVIATIONS
A.m-1	Amperes per meter
ACGIH	American Conference of Governmental Industrial Hygienists
Acute	A condition where a high dose or concentration is delivered in a single short term event, causing rapid and often significant consequences
ADNOC Group	ADNOC Group includes the Directorates & Functions in ADNOC Head Quarter, Group Companies and Affiliates
ALARA	As Low and Reasonably Achievable; A principle of risk management according to which exposures are kept As Low As Reasonably Achievable, economic and social factors being taken into consideration
ALARP	As Low As Reasonably Practicable; Means to reduce a risk to a level which is as low as reasonably practicable and involves balancing reduction in risk against the time, trouble, difficulty and cost of achieving it. This level represents the point, objectively assessed, at which the time, trouble, difficulty and cost of further reduction measures becomes unreasonably disproportionate to the additional risk reduction obtained.
Alpha Particles (α)	These are double charged cations, composed of two protons and two neutrons, which are ejected monoenergetically from the nucleus of an atom when the neutron to proton ratio is too low.
Ambient Temperature	Temperature of the environment that is surrounding the body.
ANSI	American National Standards Institute.
ATEX	ATmosphere EXplosibles; rating of equipment suitable for use in explosive atmospheres.
Attenuation	The technique for the reduction of noise or noise effect.
Audible Sound	The frequency range of sound which is normally heard by the human ear. Audible sound normally ranges between 20 Hz and 20,000 Hz.
Audiogram	A chart, graph, or table resulting from an audiometric test showing an employee's hearing threshold level as a function of frequency, sound intensity and pitch.
Audiometry	A test for measuring hearing acuity for variations in sound intensity and pitch, involving thresholds and differing frequencies.
Baseline Audiogram	The initial audiogram against which subsequent audiometric readings are compared.
Baseline Survey	Baseline Survey also called Basic Scoping Survey, is an exposure assessment strategy employed when the Qualitative OHRA reaches one or more of the conclusions: there is an exposure risk, but its extent is uncertain; a new process is being commissioned; an unusual activity is planned; significant changes were made to an existing process; control measures were introduced since the last assessment was made.
Becquerel (Bq)	The SI unit of radioactivity. One Bq is equal to one nuclear disintegration per second. Bq is used as: ▪ A measure of surface contamination, Bq/cm2 ▪ A measure of air activity concentration, Bq/m3

TERMS	DEFINITIONS/ABBREVIATIONS
	▪ A specific activity per unit mass, Bq/g or Bq/kg
Best Available Techniques (BAT)	The most effective and advanced stage in development of activities and their methods of operation which indicates the practical suitability of particular techniques for providing in principle the basis for Emission Limit Values (ELVs) designed to prevent and where this is not practicable, generally to reduce emissions and the impact on the environment as a whole. 'Techniques' includes both the technology used and the way in which the installation is designed, built, maintained, operated and decommissioned.
Beta Particles (β)	These are electrons ejected at high speeds from the nucleus of an unstable atom when a neutron spontaneously converts to a proton and an electron.
BOHS	British Occupational Hygiene Society.
Broadband Noise	Noise that has a continuous frequency spectrum, i.e. sound energy is present over a wide range of frequencies.
BS	British Standard.
BS EN	British Standard European Norm.
CCOHS	Canadian Centre for Occupational Health & Safety.
CE	Conformité Européene. CE marking is a certification mark that indicates conformity with health, safety, and environmental protection standards for products sold within the European Economic Area. The CE marking is also found on products sold outside the EEA that are manufactured in, or designed to be sold in, the EEA
CIH	Certified Industrial Hygienist.
COH	Certified Occupational Hygienist.
Company	Company is an incorporated business body. An organization engaged, as principal or contractor, directly or indirectly, in the exploration for and production of oil and/or gas/Petrochemicals/Fertilizers or any manufacturing product or Marketing or Services. For bodies or establishments with more than one site, a single site may be defined as a Company.
Conduction	Transfer of heat from one point to another within a body, or from one body to another when both bodies are in physical contact, in the absence of motion in the medium.
Contractor	A 'Contractor' is defined as an individual or organization having a contract/sub-contract with ADNOC Group for the provision of services, equipment or performance of works. The term "Contractor" as used in the ADNOC Group Contracts Procedure is synonymous with the terms including but not limited to "Consultant", "Sub-Contractor", "Service Provider" or "Supplier".
CP	Corporate Practice
Core Temperature	Human body temperature dependent on the individual's metabolic rates.

TERMS	DEFINITIONS/ABBREVIATIONS
Corrective Action	Action taken to eliminate the cause of nonconformity.
Curie (Ci)	The old unit of radioactivity. This has been replaced by the Becquerel (Bq). One Ci is equal to 3.7×1010 Bq.
CWM-AD	Centre for Waste Management - Abu Dhabi.
dB	Decibel-Unit of Sound.
dBA (A-Weighted Network)	Refers to one of three weighing networks of a sound level meter. The "A" network discriminates against or 'filters' low frequencies to a greater extent than the other networks and simulates the response of the normal ear to frequencies below 500Hz. The A-weighting is used because studies have shown that it gives a better estimation of threat to hearing from noise exposure than do the other weightings.
dBC (C-Weighted Network)	Unit representing the sound level measured with the C-weighting network on a sound level meter.
Dose	The amount of agent deposited within the body. Typically, the distinction between exposure and dose is blurred, although in reality, significantly different doses can result from the same exposure.
Dose Constraint	A prospective and source-related restriction on the individual dose from a source, which provides a basic level of protection for the most highly exposed individuals from a source and serves as an upper bound on the dose in optimisation of protection for that source. For occupational exposures, the dose constraint is a value of individual dose used to limit the range of options considered in the process of optimisation. For public exposure, the dose constraint is an upper bound on the annual doses that members of the public shall receive from the planned operation of any controlled source.
DV	Dilution Ventilation.
EAV	Exposure Action Value (EAV) - 2.5 m/s2 A (8) (exposure averaged over a day). Wherever exposure at or above this level occurs, actions (including health surveillance) are required to control the risk.
Electrolyte	Minerals dissolved in body fluids and cells.
ELF	Extremely Low Frequency.
ELV	Exposure Limit Value (ELV) - 5 m/s2 A (8) (exposure averaged over a day). This is the maximum vibration exposure permitted for any individual on a single day.
EMF	Electromagnetic Field.
EN	European Standard.
Engineering Control	These are methods that are built into the design of a plant, equipment or process to minimize the hazard.
EPC	Engineering, Procurement and Construction.
Evaporation	Evaporation is the process by which water changes from a liquid to a gas or vapour. Water boils at 212 °F (100 °C), but it actually begins to evaporate at 32 °F (0 °C).
Exchange Rate (ER)	The exchange rate is the amount by which the permitted sound level may increase if the exposure time is halved. In ADNOC, we follow the 3 dB exchange rate as per UK-HSE regulations and NIOSH/ACGIH guidelines.
FANR	Federal Authority for Nuclear Regulation.

TERMS	DEFINITIONS/ABBREVIATIONS
FEED	Front End Engineering Design.
Frequency	The number of vibrations (or cycles) per second, measured in units of Hertz (Hz).
Gamma Particles (γ)	A nucleus which is in an excited state may emit one or more photons (packets of electromagnetic radiation) of discrete energies. The emission of gamma rays does not alter the number of protons or neutrons in the nucleus but instead has the effect of moving the nucleus from a higher to a lower energy state (unstable to stable).
Gray (Gy)	SI unit for the absorbed (energy) Dose. One Gray equals 1 J/kg.
Group Company	Means any company within the ADNOC Group, other than ADNOC.
Half-life, Radioactive	The time required for a radioactive material to lose half of its activity through radioactive decay.
Health Hazard	The potential to cause harm to health. Health hazards may be biological, chemical, physical, ergonomic or psychological in nature. 'Health hazards' are also known as 'agents hazardous to health' and 'hazardous agents'. These terms are interchangeable.
Health Risk	Health risk is the combination of likelihood that harm to health may occur (which is related to exposure) multiplied by the severity of health effects (hazard).
Heat Cramps	Painful intermittent spasms of the muscles following hard physical work in a hot environment that leads to a large loss of salt and water.
Heat Exhaustion	A condition whose symptoms may include; profuse sweating, weakness, rapid pulse, dizziness, nausea and headache.
Heat Stroke	A serious condition where the body is no longer able to cool itself and a person's body temperature becomes dangerously high.
HEPA	High Efficiency Particulate Air.
HPD	Hearing Protection Device.
HSE UK	Health & Safety Executive – United Kingdom.
HSEIA	Health, Safety & Environmental Impact Assessment. A systematic process of identifying HSE impacts of existing, new or substantially altered projects, and establishing prevention and mitigation requirements.
HSEMS	Health, Safety & Environmental Management System.
HVAC	Heating, Ventilation & Air Conditioning.
Hz	Hertz, a unit of sound frequency.
ICNIRP	International Commission on Non-Ionizing Radiation Protection.
IEC	International Electrotechnical Commission.
Impulse or Impact Noise	This is characterized by a sharp rise and rapid decay in sound levels and is less than 1 second in duration.
Industrial Hygienist	An individual who has met the minimum requirements for education and experience dedicated to anticipating, recognizing, evaluating, and controlling workplace conditions that may cause workers' injury or illness.

TERMS	DEFINITIONS/ABBREVIATIONS
IR	Infrared Radiation.
ISO	International Organization for Standardization.
J/m2	Joules per square meter.
kHz	Kilohertz=1,000 Hz.
LED	Light Emitting Diode.
LEV	Local Exhaust Ventilation.
Low Specific Activity (LSA)	LSA material shall mean radioactive material which by its nature has a limited specific activity, or radioactive material for which limits of estimated average specific activity apply.
Lux	Unit of luminance, used in illumination measurement.
MDHS	Methods for the Determination of Hazardous Substances.
Microprocessor Audiometer	Electronic audiometer which is used with a software controller.
NDT	Non-Destructive Testing.
NIHL	Noise-Induced Hearing Loss.
NIOSH	National Institute for Occupational Safety and Health – United States.
NIR	Non-ionizing Radiation.
nm	Nanometre.
Non-Conformance	Non-fulfilment of a requirement. Note: It can be any deviation from relevant work standards, practices, procedures, legal requirements, etc.
Non-Routine Operations	Work conducted that is not routine day to day activities and not covered by written procedures. Non-Routine Operations can include; special heavy lifts, sand / grit blasting, entry into a confined space and any activity that requires permit to work.
NORM	Naturally Occurring Radioactive Material.
Occupational/Industrial Health	A multidisciplinary field aimed at: - the protection and promotion of the health of workers by preventing and controlling occupational diseases and injuries by eliminating occupational factors and conditions hazardous to health and safety at work -
Occupational Health Management System	A management system comprised of set of policies, guidelines and procedures related to occupational health.
Occupational/Industrial Hygiene	It is the discipline of anticipating, recognising, evaluating and controlling health hazards in the working environment with the objective of protecting worker health and well-being and safeguarding the community at large.
Occupationally Exposed Workers (Radiation)	Any person who works full-time, part-time or on a temporary basis for a Licensee and who has recognized rights and duties in relation to occupational radiation protection.
OHRA	Occupational Health Risk Assessment – the identification of health hazards in the workplace and subsequent evaluation of risk to health, taking account of impact to health and likelihood of exposure.

TERMS	DEFINITIONS/ABBREVIATIONS
OSHA	Occupational Safety and Health Administration (United States).
Peak sound level	A measure of the maximum instantaneous sound pressure at a specified location.
Physical Agents	These are sources of energy that may cause injury or disease. Examples of physical agents include noise, vibration, radiation, and extremes in temperature and pressure.
PPE	Personal Protective Equipment; any device or appliance designed to be worn or held by an individual for protection against one or more health and safety hazards.
Project	Planned set of interrelated tasks to be executed over a fixed period and within certain cost and other limitations.
Qualitative OHRA	Qualitative OHRA is a descriptive measure and relies upon determination of severity (impact) and probability of risk related to health hazards in the workplace taking into account existing control measures.
Quantitative OHRA	Quantitative OHRA makes use of sampling and analytical techniques to quantify the exposure concentration of the hazardous agents to which the workers are potentially exposed, and using data obtained to determine likelihood of risk to health hazards.
Rad	The old unit of radiation dose absorbed (rad). The equivalent SI unit is the Gray which is equal to 0.01 rad.
Radiation	A type of energy travelling in the form of waves or particles.
Radiation Protection Officer	A person technically competent in Radiation Protection matters relevant for a given type of Regulated Activities with Regulated Material who is designated by the Licensee to oversee the application of relevant requirements established in this FANR Regulation 24.
Record	Document stating results achieved or providing evidence of activities performed.
Rem	The old unit of radiation dose equivalent and has been replaced by the Sievert. 100 Rem is equal to 1 Sievert.
RF	Radio Frequency.
Risk Assessment	The process of determination of risk, usually in a quantitative or semi-quantitative manner. It is an evaluation of the likelihood of undesired events and the likelihood of harm or damage being caused together with the value judgements made concerning the significance of the results.
RPE	Respiratory Protective Equipment.
Shielding	The reduction of radiation beam intensity by interposing, between the source and an object or person that might be exposed, a substance that absorbs radiation energy, either by collision, in the case of particulate radiation, or by absorption of waveform energy, in the case of gamma photons.
Sievert (Sv)	The SI unit of radiation dose equivalent. Occupational radiation dose limits are specified in units of milliSievert (mSv). In NORM measurements, it is usual to measure in the microSievert (µSv) or nanoSievert (nSv) ranges. All measurements of radiation dose-rate are provided as a rate per hour, e.g. 10 microSieverts per hour (10µSv/hr).

TERMS	DEFINITIONS/ABBREVIATIONS
SLM	Sound Level Meter.
Sound Exposure Level	The equivalent continuous noise level of an event including all the actual noise then referenced to a duration of 1 second.
Sound Power Level	The total amount of noise inherent in a particular noise source independent of the acoustic environment.
Sound Pressure Level	The instantaneous changing sound level with a selected frequency weighting and time response.
SOW	Scope of Work.
TLV	Threshold Limit Value.
TWL	Thermal Work Limit.
UK-HSE	United Kingdom – Health and Safety Executive.
UV	Ultraviolet.
VWF	Vibration White Finger.
WBV	Whole Body Vibration.
Wet Bulb Globe Temperature (WBGT)	The temperature index represents the measurement of environmental factors which most nearly correlate with deep body temperature and other physiological responses to heat.
WHO	World Health Organization.
µm	Micrometer.

08. REFERENCES

1. UAE Cabinet Decree (12) of 2006 Regarding Regulation Concerning Protection of Air from Pollution, Annex (6) Allowable Limits for Noise Level in Different Areas
2. FANR-REG-06 Version 0 - Regulation for an Application for a Licence to construct a Nuclear Facility.
3. FANR-RG-006 - Transportation Safety Guide
4. FANR-RG-007, Version 1. Radiation Safety Guide
5. FANR-REG-10, Regulation for the System of Accounting for and Control of Nuclear Material and Application of Additional Protocol, Version 0
6. FANR-REG-13 Version 0 - Regulation for the Safe Transport of Radioactive Materials
7. FANR REG 18 Predisposal of Radioactive Waste
8. FANR-RG-019 - Radiation Safety in Industrial Radiography
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09. APPENDICES

APPENDIX 1 - AREA NOISE MEASUREMENT

APPENDIX 2 - PERSONAL NOISE DOSIMETRY

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APPENDIX 1 - AREA NOISE MEASUREMENT

Date / Period		**Instrument Name**	
ADNOC Group		**Brand**	
Department / Section		**Model**	
Facility / Unit No.		**Type / Class**	
Name of Facility / Unit		**Last Calibration Date**	
Done by		**Next Calibration Due Date**	

No.	Noise Source Location	LAeq (dB)	Comments / Remarks

APPENDIX 2 - PERSONAL NOISE DOSIMETRY

Date / Period		**Instrument Name**	
ADNOC Group		**Brand**	
Department / Section		**Model**	
Facility / Unit No.		**Type / Class**	
Name of Facility / Unit		**Last Calibration Date**	
Done by		**Next Calibration Due Date**	

No.	Name of Employee	ID No.	Job Title	Dosimeter Serial No.	Date	Start Time	Stop Time	LAep, d	HPD Used	Work Activity / Location / Other Comments
1										
2										
3										
4										
5										
6										
7										
8										
9										
10										

APPENDIX 3 - OCTAVE BAND ANALYSIS

Date / Period		**Instrument Name**	
ADNOC Group		**Brand**	
Department / Section		**Model**	
Facility / Unit No.		**Type / Class**	
Name of Facility / Unit		**Last Calibration Date**	
Done by		**Next Calibration Due Date**	

No.	Noise Source Location / Area	Frequency Band (Hz) – dB(A)										LAeq (dB)	LCpk (dB)	Comments / Remarks
		31.5	63	125	250	500	1000	2000	4000	8000	16000			
1														
2														
3														
4														
5														
6														
7														
8														
9														
10														

APPENDIX 4 - HEAT STRESS SITE ASSESSMENT CHECKLIST

ADNOC BEAT THE HEAT 2019 CHECKLIST	
Date	
Time	
Contractor	
Location	
HSE Representative	
Contact Details	

Sr. #	Observation	Y/N/NA	Remarks
1.0	**Rest Shelter Available**		
	Sitting Arrangement		
	Cooling Arrangement (Fan or AC)		
	Heat Stress Awareness Posters		
2.0	**Drinking Water Stations/Igloos (Cool Water)**		
	Regular Water Supply		
	Personal Water bottles		
3.0	**Urinals**		
	Urine Charts displayed for information		
4.0	**Onsite TWL Measurements and records**		
	Flagging System or PAGA System		
	Rehydration Work Rest Regime as per TWL Guidelines for workforce (includes adjusted regime for high risk health status workforce) as applicable		
5.0	**Training & Communication**		
	Heat Stress Awareness Training		
	Heat Stress Awareness Posters/Banners		
	Daily Tool Box Talks		
	Work/Rest Schedules		
	Buddy System (No One Working Alone)		
	Compliance to Midday Break		
6.0	**Medical & Emergency Preparedness**		
	Adequate in number Workplace-designated First		
	Aiders		
	Approved First Aid Medical Centre nearby Location		

Sr. #	Observation	Y/N/NA	Remarks
	Adequate Medical Supplements (e.g. ORS, Electrolyte, Isotonic solutions)		
	Clear Access to Work Place in Case of an Emergency		
	Adequate Acclimatization for New Workers, Existing Personnel whole are on rotational leave (includes identified high risk health status group)		
7.0	**Additional Items**		
Completed By:			

Weekly checklists to be completed and sent to _____ or _____
Highlight any good, substandard practices and areas of concern for information sharing with other locations (include pictures if available).

APPENDIX 5 - AREA/WORKPLACE HEAT STRESS EVALUATION

Date and Time		**Instrument Name**	
ADNOC Group		**Brand and Model**	
Name of Unit and Facility		**Last Calibration Date**	
Done by		**Next Calibration Due Date**	

Name of Specific Area / Workplace		**Heat Generating Equipment (Please specify)**		
Parameters	**Abbreviation**	**Unit of Measure**	**Readings**	**Comments / Remarks**
Relative Humidity	RH	%		
Dry Bulb	DB	°C		
Wet Bulb	WB	°C		
Globe Bulb	GB	°C		
WBGT	WBGT	°C		
Wind Speed	WS	m/s		
Heat Index	HI	°C		
Thermal Work Limit	TWL	W/m2		
Work Zone Category	G / A / R	Green / Amber / Red	Green	

Name of Specific Area / Workplace				
Parameters	**Abbreviation**	**Unit of Measure**	**Readings**	**Comments / Remarks**
Relative Humidity	RH	%		
Dry Bulb	DB	°C		
Wet Bulb	WB	°C		
Globe Bulb	GB	°C		
WBGT	WBGT	°C		
Wind Speed	WS	m/s		
Heat Index	HI	°C		
Thermal Work Limit	TWL	W/m2		
Work Zone Category	G / A / R	Green / Amber / Red	Red	

APPENDIX 6 – FLAGGING SYSTEM FOR HEAT STRESS LEVELS

1. INTRODUCTION

Notifying workers on changing heat stress risk levels while at work is essential to reduce and mitigate the effects of heat stress. Timely notification to the workers regarding changing Thermal Work Limits due to changes in hot weather conditions/environment so that they can take appropriate/defined protective measures to reduce further exposure to excessive heat levels. The lack of notification or awareness could lead to increase in the number of heat stress illness incidents and accidents due to impaired health status while at work.

This communication could be done through telecommunication/mobile messaging or using flag system (erecting different colour flags) based on the Thermal Work Limit (TWL) Risk level.

2. IMPLEMENTATION AND EXPECTATIONS

This colour coded flagging system is applicable where multiple teams are working at different and distant locations and single source of monitoring of heat stress is used (e.g., area heat stress monitoring device capability).

It is also recommended that if different areas are affected with different environment and the heat stress effect could be varying in these locations then each area shall be provided with a separate measuring instrument (i.e., Thermal Work Limit meters) for knowing actual heat stress levels in that particular work area. The TWL device shall be annually calibrated.

The colour coded flagging system shall be implemented during the summer months (i.e., May to October). Each Group Company (through its Site Operations Manager) shall be responsible in the preparation of such colour coded flags for distribution to their appropriate operational sites and facilities.

3. FREQUENCY AND LOCATION OF COLOUR CODED FLAGGING SYSTEM

The colour coded flagging system shall be implemented throughout the daytime hours only (i.e., 7 am to 6 pm) during the summer months. Site Operations team shall designate an appropriate representative who shall be responsible in placing the flag and updating the appropriate flag colour four (4) times during day shift. Timing of flag colour updating shall be defined by GC operational sites.

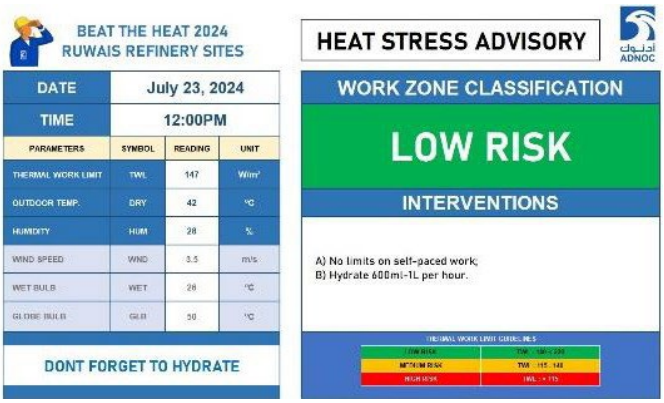
The flag shall be placed on a visible location (i.e., on the roof of a building/ flagpole or at least 3 meters above the ground and a spot where a flag can be installed). Thermal Work Limits shall be monitored four (4) times during day shift, and appropriate flag colour shall be placed on its designated location.

4. NOTIFICATION TO EMPLOYEES AND CONTRACTORS -FLAGGING SYSTEM

To effectively implement the system, it is essential to communicate the colour of Flag-and its instruction across all employees and contractors working at sites. Following is the strategy may be adopted.

- Notification to all employees and contractors through common email to all employees-computer users/ Supervisors /contract holders/ and respective team. Notification to department and contractor focal points/Supervisors through email and pager and raising of TWL zone flags.
- If the flag colour is Red, then communication through PAGA System to all about the status of the Flag, with the Precautions need to follow during the Period.
- Thermal Work Limit Values may also be disseminated via SMS specially for worker assigned in remote areas so they will be able to receive periodic advisory on the heat stress risk levels.

Notification format through email can be written as follows: Beat the Heat Stress Advisory:

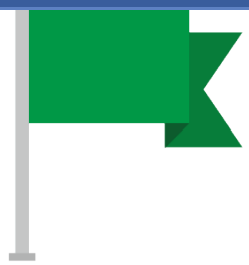
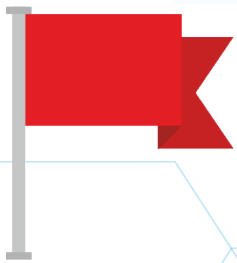


For notification purposes via Email and SMS, it is recommended to state the Heat Stress Risk Level and TWL value along with the hydration and work rest schedule

5. EXEMPTION REQUIREMENTS DURING THE MID DAY BREAK

During the Mid-Day break period-(12;30-3:00 pm) (15th June-15th September), the Flag system remains applicable, and all precautionary measures shall be communicated. If the site or location is allowed through internal approvals as applicable from the Mid-Day break, the specific location shall have the TWL meter monitoring with the Flag system in place, together with the periodic advisory (disseminated four (4) times a day) for that specific work location to ensure the effective and safe implementation of the Heat stress prevention requirements.

6. COLOUR CODED FLAGGING SYSTEM

Flag Color	Thermal Work Limit (W/m2)	Work: Rest Period (minutes)	Water Requirements per hour	Additional Controls
	140-220 Low Risk	Continuous	600 to 1000 mL	No limit on self-paced work
	115-140 Medium Risk	• Continuous for LIGHT work • 45:15 for HEAVY work	• 1000 to 1200 ml (LIGHT work) • >1200 ml (HEAVY work)	• Shaded areas, mechanical ventilation • Working alone to be avoided • Unacclimatized workers not allowed
	<115 High Risk	• 45:15 for LIGHT work • 20:40 for HEAVY work	>1200 ml	• Working alone NOT allowed • Unacclimatized workers NOT allowed • Continuous monitoring of heat stress signs on workers • Water bottle (2 liters) mandatory at all times

***Light work = sitting or standing, light arm work; Heavy work = carrying, climbing, lifting, pushing, or whole-body work.**

7. COLOUR RACI MATRIX FOR COLOURED FLAG GUIDANCE IMPLEMENTATION

Expectation	GHSE	CHSE	Site HSE	Employees	Site/Activity Supervisors*
1) Development of Flag System interim guidance	R, A	C	I	I	I
2) Preparation and dissemination of coloured flags	_	C	_	I	R, A
3) Replacement and removal of flags as appropriate four (4) times a day. Perform audible notification of flag colour via PAGA System.	_	_	_	I	R**, A
4) Monitoring of Thermal Work Limit Values*	_	I	C	I	R*, A
5) Spot/inspection checks on flag installations on designated areas	_	_	R, A	I	C
6) Implementation of appropriate heat stress control measures depending on flag colour (including close monitoring/inspection for the exempted work activities and recordkeeping as appropriate)	_	C	C	I	R, A
7) Adherence to appropriate heat stress control measures	_	I	C	R	A
8) Training of Crew with the proper use of TWL devices, TWL provisions and colour coding	_	C	R	I	A

Legend

GHSE: Group Health Safety & Environment Function, particularly Occupational Health

Site HSE: This includes but not limited to: OH SMEs. Safety Officers/Coordinators/Team Leads

* Site/Activity Supervisors: Site/Activity Supervisors shall monitor TWL values as long as they are properly trained, and as long adequate TWL units are available.

**As delegated by Rig Manager to his Operations person.

APPENDIX 7 - HEAT STRESS MONITORING - TWL MONITORING SUMMER MONTHS IMPLEMENTATION

Month / Year		**Instrument Name**	
ADNOC Group		**Brand and Model**	
Monitoring Location		**Last Calibration Date**	
Done by		**Next Calibration Due Date**	

Parameters	Abbr.	Unit	Date	2	3	4	5	6	9	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	-
			Time	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	9:00	-
Relative Humidity	RH	%																							
Dry Bulb	DB	°C																							
Wet Bulb	WB	°C																							
Globe Bulb	GB	°C																							
WBGT	WBGT	°C																							
Wind Speed	WS	m/s																							
Heat Index	HI	°C																							
Thermal Work Limit	TWL	W/m^2																							
Risk Category	G/A/R	-																							

Parameters	Abbr.	Unit	Date	2	3	4	5	6	9	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	-
			Time	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	11:00	-
Relative Humidity	RH	%																							
Dry Bulb	DB	°C																							
Wet Bulb	WB	°C																							
Globe Bulb	GB	°C																							
WBGT	WBGT	°C																							
Wind Speed	WS	m/s																							
Heat Index	HI	°C																							
Thermal Work Limit	TWL	W/m^2																							
Risk Category	G/A/R	-																							

Parameters	Abbr.	Unit	Date	2	3	4	5	6	9	10	11	12	13	16	17	18	19	20	23	24	25	26	27	30	-
			Time	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	3:00	-
Relative Humidity	RH	%																							
Dry Bulb	DB	°C																							
Wet Bulb	WB	°C																							
Globe Bulb	GB	°C																							
WBGT	WBGT	°C																							
Wind Speed	WS	m/s																							
Heat Index	HI	°C																							
Thermal Work Limit	TWL	W/m^2																							
Risk Category	G/A/R	-																							

APPENDIX 8 - RADIOACTIVE SOURCE INVENTORY REGISTER

ADNOC GROUP - RADIOACTIVE SOURCES INVENTORY REGISTER																													
	Licensee		FANR License						UTM Coordinates				TAG Numbers				Radioactivity												
ADNOC Group Sl. No.	Company Sl. No.	Group Company	No.	Expiry Date	Location/Asset	RA Source Manufacturer & Country of Origin	Date of RA Source Entry to Company	Date of Source Removal (Export) from Co. License	UTM Zone	Easting (M)	Northing (M)	Equipment / vesset associated with the Radioactive source	R. Source	Instrument Model No.	Sl No.	Radio-isotope Materials	m Ci	MBq	Conversion Factor	GBq	TBq	D_ Value (TBq)	Ratio A/D	Application	Shield Type	Name of Assigned RPO	RPO Contact Numbers	Remarks (Group Company)	Remarks (ADNOC GHSE Unit)

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